POWER

Volume 61 New York, March 24, 1925 *No.* 12

Systematic Overhauling

ISN'T it a grand and glorious feeling when you get something all fixed and it runs?

It may be a machine that has been balking, it may be a plant that you have seen through its assemblage and erection, it may be a realization in iron and steel of an idea or design of your own.

And it is great to see it whirl along, accomplishing its intended purpose, and to listen to its purr and click as everything works in its appointed time and place, according to your design.

How nice it would be, how much time and worry it would save, if things would stay fixed once they were got to working smoothly.

But they won't!

Boilers will scale up, furnace walls will spawl and fuse, condensers will foul up and leak, and engines, pumps, turbines, generators and motors, pipe lines, valves and fittings, circuits, everything about the plant has some ill to which it is subject, and is liable to a manifestation of trouble which may involve more or less of the others and lead to that bugbear of the operating engineer, a shutdown.

Fortunate is the man who is on intimate terms with all the constituents of his plant, who knows their inner workings, their crotchets, their condition and their symptoms of uneasiness and threatened distress.

Smooth is his path who does not wait for intimations of trouble, but keeps himself informed of what is going on in the hidden places. Fixed times for inspection and tuning up will not only keep things working at their best efficiency, but will often forestall trouble and accident.

It means some spare equipment, it means work out of hours when the plant is shut down, it means orderly procedure, according to schedule, with a record of conditions found and insistence upon their being made right, but it will pay big in the long run in efficient uninterrupted service, long life to the equipment and credit to the man in charge.

F. R. Low

Island Station of St. Paul Gas Light Company

INITIAL 25,000-kw. unit of proposed three-unit plant now in operation. Powdered coal is the fuel with air ventilated furnace walls and water screens to prevent the slagging of ash. The coal is dried by flue gases. Combination superheaters are installed, and stage bleeding of the main unit at four points is in effect. Economizers and air preheaters have been omitted, but space is available should their installation be desired later.

PLACED in operation in December, 1924, the Island Station of the St. Paul Gas Light Company embodies many of the latest developments in power-plant engineering. Designed as a stand-by plant, it has been equipped to burn pulverized coal. Superheaters of the combined convection and radiant types give a final steam temperature of 650 deg. F. The operating pressure is 325 lb. gage. With four-point bleeding, steam is drawn from three stages of the main turbine for feed-water heating and additional steam from a fourth stage is withdrawn for the purpose of heating the building.

The location on an island at the east side of the Mississippi River affords excellent facilities for receiving coal by railway or by water transportation up the Mississippi, a development which undoubtedly will be realized within the near future. At periods of high water the island was completely submerged, but has been partly filled up to 3 ft. above the high-water level. The location made possible short tunnels for circulating water, and the system has been designed to operate as a siphon.

The maximum difference between high- and low-water levels on record is 25 ft. To provide for this range necessitated a certain maximum elevation for the condenser floor above low water. The soil conditions, together with the variable water levels, made it advisable to erect the building on a pile foundation. From the piling to 30 ft. above the building is constructed as a concrete float, with a 4-ft. reinforced-concrete mat resting on 1,400 wooden piles and reinforced-concrete side walls. To insure against water entering the building, the entire floor and walls were waterproofed 3 ft. above the high-water level.

As shown in the sectional elevation, Fig. 2, the initial plant is divided into five bays, with the coal-handling equipment in the bay on the channel side of the building, then the boiler room, heat balance and pump bay, the turbine room, and the electrical bay on the north side of the building. The coal is delivered on private right-of-way from the main line of the St. Paul, Minneapolis & Omaha Railway, weighed in on the track scale and dumped into the track hopper from bottom dump cars. It is then elevated 125 ft. by an automatic skip hoist to the coal receiving hopper, from which it passes over a reciprocating feeder, magnetic separator and grizzly, and through a double-roll crusher onto the distributing conveyor delivering automatically into three 200-ton crushed coal bins. The coal-handling apparatus as installed has ample capacity for two units.

Inasmuch as the station is to serve as a stand-by plant, it was decided that two driers would have sufficient capacity for the present, one below each of two bunkers, with the third bunker used for storage. A temporary coal chute from this bunker to the track hopper makes it possible to transfer the coal to the other bunkers when desired. For drying, the hot gases from the base of the stack are drawn through the coal and discharged back to the stack. The gases passing to the drier are maintained at a constant temperature of 325 deg. F. by means of thermostatic dampers allowing a certain amount of outside air to be drawn in with the stack gases.

Each drier feeds one six-ton mill. The pulverized coal is conveyed from the mills to the conveyor floor by a low-pressure air system. At the conveyor floor the pulverized coal and air are separated by two cyclone collectors, one 7 ft. and the other 4 ft. in diameter. The two were used as previous installations had experienced the trouble of a considerable amount of coal dust being vented to the air from one collector. In this case the larger collector is vented to the smaller one and the latter to the atmosphere, so that in operation the coal dust lost with the excess air is negligible. From the collectors the coal is carried in 12-in. extra-heavy cast-iron screw conveyors to the boiler room and distributed by two 12-in. screw conveyors to each of four 70-ton pulverized-coal bunkers. The total amount of power required for drying, pulverizing and conveying in the pulverizing plant is 18.8 kw.-hr. per ton. Of this amount 3.9 kw.-hr. is required for drying, 8.2 kw.-hr. for pulverizing and 6.7 kw.-hr. for conveying. These factors are based on using Youghiogheny screenings with approximately 6 per cent moisture.

With the layout arranged for four boilers, three are installed at present, each being of the cross-drum type with two rows

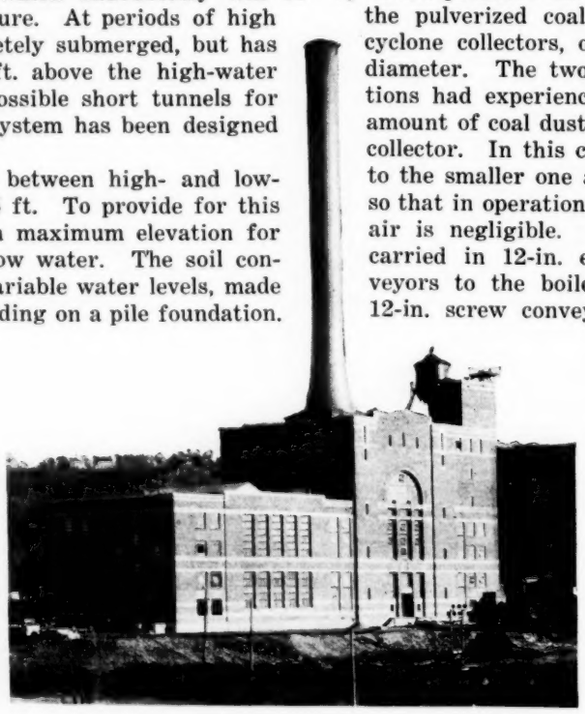


Fig. 1—Island Station of St. Paul Gas Light Co.

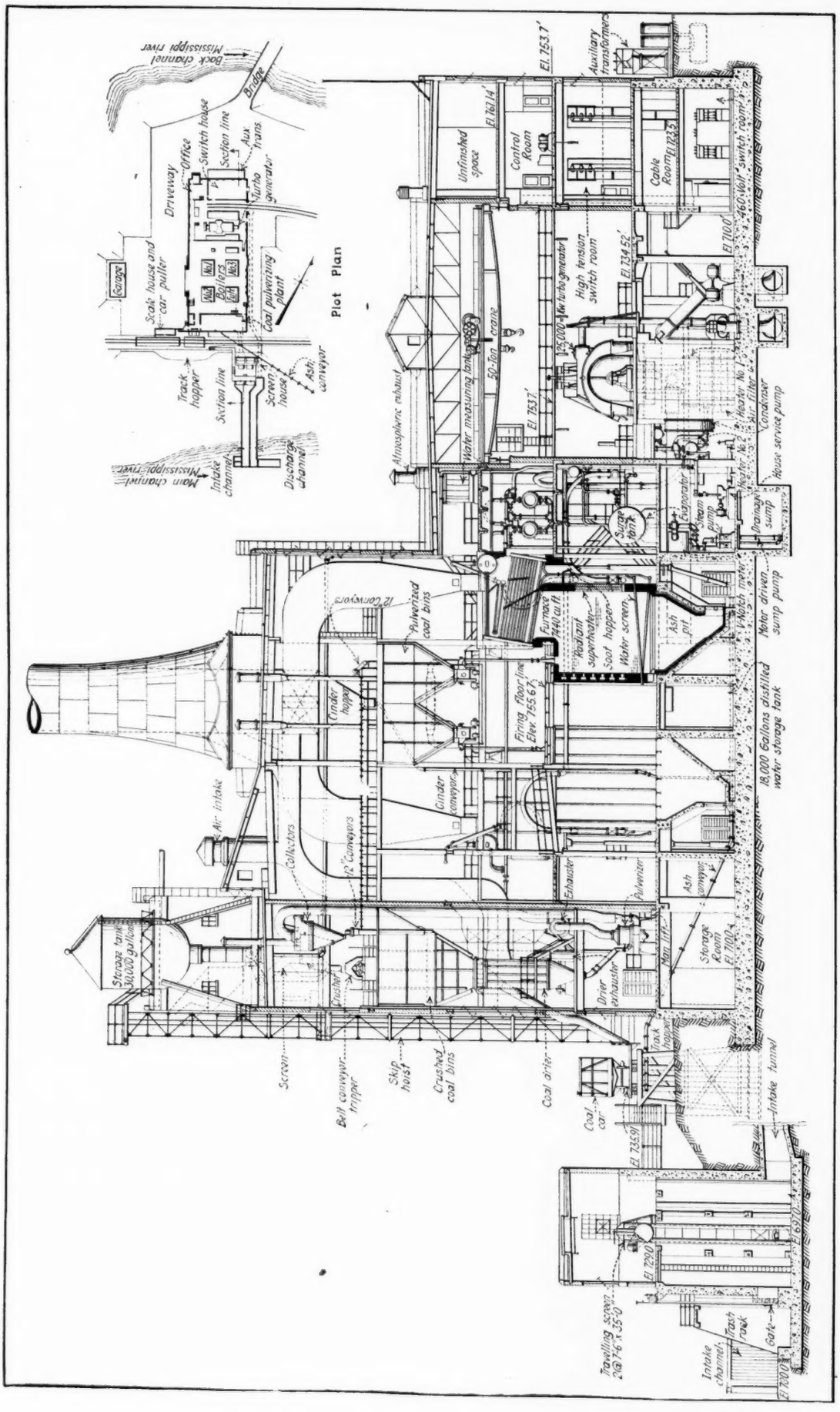


Fig. 2—Cross-section through Island station of St. Paul Gas Light Company

of circulating tubes from the front water leg to the drum. Inclined plastic baffles vary the cross-sectional area of the gas passes so as to insure practically uniform velocity of the gases through the boiler. The free areas and the heating surface in each pass are as follows:

Free Area of Gas Passes, Sq.Ft.		Heating Surface, per Cent	
Entering first pass	111	First pass	50.3
Leaving first pass	67	Second pass	26.3
Entering second pass	58	Third pass	23.4
Leaving second pass	40		
Entering third pass	39		
Smoke outlet	38		

In each boiler the convection superheater is installed between the circulating tubes and the top row of boiler tubes. The radiant superheater forms part of the rear furnace wall. The boilers and superheaters are designed to operate at 325 lb. gage and 650 deg. F. total steam temperature. However, they are operated to deliver steam at 275 lb. and 650 deg. F. at the turbine throttle. It is said to be possible to control the steam temperature within 10 deg. F. of the desired limits by controlling the operation of the soot blowers on the radiant superheater.

From tests on one of the boilers the data shown graphically in the accompanying curves were obtained. Tests were conducted with the boiler at a constant load and the CO_2 varied from 16 to 8 per cent. Curve Sheet, Fig. 3, shows the exit gas temperature and draft loss plotted against the percentage of CO_2 in the flue gases by volume. In both cases operation was held constant at 150 per cent of rating. Both curves illustrate clearly the importance of high CO_2 to maintain in the first place a low exit gas temperature and, secondly, a low

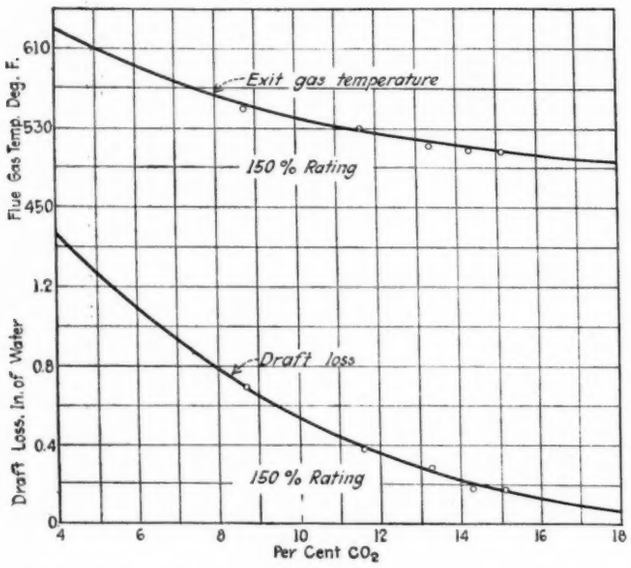


Fig. 3—Variation of exit gas temperature and draft loss with percentage of CO_2

draft loss, the latter varying approximately as the square of the CO_2.

Curves of Fig. 4 show graphically the actual results obtained with this unit as against the manufacturers' guaranteed values. Full lines indicate the results of tests and the dotted lines the manufacturers' guarantees. Inasmuch as the tests were conducted with CO_2 somewhat lower than anticipated, the exit gas temperatures in particular were higher than the guarantees, but by making the proper corrections the losses fell well within the guarantees.

Fig. 5 shows the temperature through the unit from the furnace to the smoke outlet. The effect of variable CO_2 is in evidence.

In Fig. 6 is shown the performance of the combination convection and radiant superheaters. As the temperature in the radiant superheater falls off at high ratings, that in the convection superheater rises by

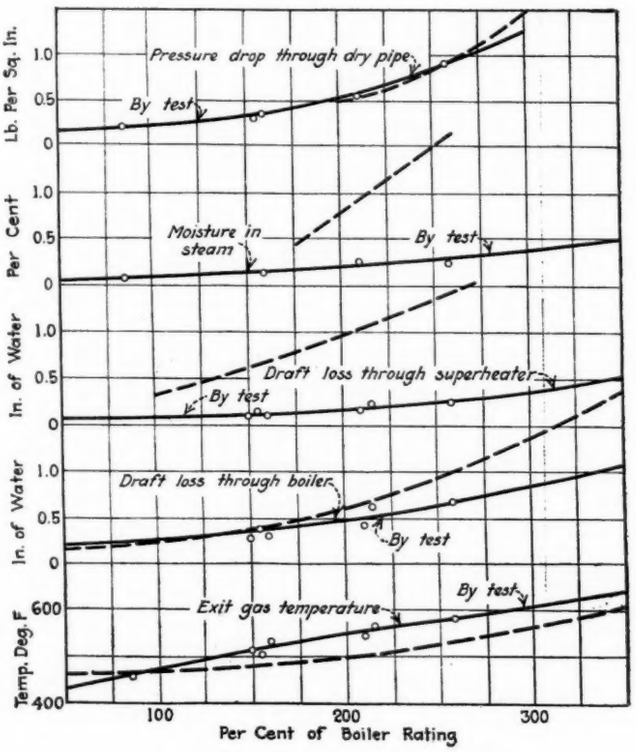


Fig. 4—Checking boiler guarantees

nearly the same amount, giving a combined superheat that is practically constant at all loads.

Coal is fed to each boiler from individual pulverized-coal bunkers of 70 tons capacity each, located directly over the firing aisle. Below each bunker are three duplex screw-type feeders, each feeder being driven through a Reeves transmission by its individual motor of the squirrel-cage induction type. To cover emergencies the center feeder of each boiler is driven also by a direct-current motor. When the station must be started from its own power, the direct-current motors drawing on storage-battery service are used to generate steam.

Each feeder supplies two burners, there being six standard corrugated fantail burners for each boiler set vertically through the furnace roof. Primary air for combustion is taken from the boiler room and drawn over the top of the arch, thereby cooling it and becoming heated itself approximately 50 deg. F. It is then delivered under pressure to the feeders, where it mixes with the fuel and passes downward through the burners to the furnace. Secondary air is drawn through ducts at the side and front walls, the air entering the ducts at the rear of the boiler through seven dampered openings, on each side of the boiler setting. Ducts from these openings extend along the side walls and across the front wall, where 56 openings

arranged in seven horizontal rows, admit the secondary air to the furnace.

Encased in steel the furnace setting consists of 4½ in. of Sil-o-cel laid up against the steel casing, a 9-in. air space for the secondary air ducts and 9 in. of firebrick. The brick used in this case are of light porous consistency and have withstood the high furnace temperatures exceedingly well.

From the pits the ashes are transferred into small hoppers on the ash-conveyor line and by a steam jet conveyed to the target box, where they are sprayed with water and sluiced out for filling.

Control of combustion in the furnaces has been simplified to such an extent that one fireman and one water tender operate the three boilers. Control of all apparatus has been centralized on the firing floor. All motors for the control of one boiler are regulated from one side of the boiler and the stack damper and primary and secondary air from the other side. Controls of the speed of feeders and the amount of primary air to the feeders are at their respective burners. Steam flow meters, draft gages and temperature instruments are located on brackets at one side of the boiler so as to be visible from any point on the firing aisle, and from the same location the smoke also can be seen.

For boiler testing, water-measuring tanks and coal-weighing apparatus have been provided. Coal is received from the 12-in. screw conveyor from the collectors and weighed in a small hopper. It is then delivered by the coal pump to the pulverized-coal bunkers.

The heat balance system consists of three closed-type heaters, a single-effect evaporator system, an evaporator

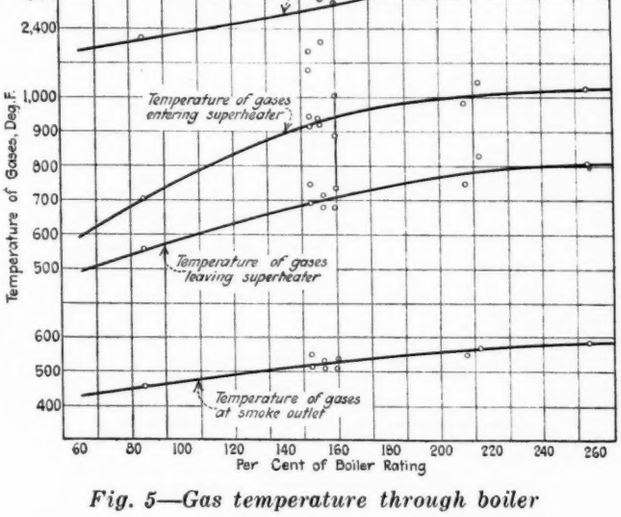

Temperature of furnace
Temperature of gases entering superheater
Temperature of gases leaving superheater
Temperature of gases at smoke outlet
Temperature of Gases, Deg. F.
Per Cent of Boiler Rating

Fig. 5—Gas temperature through boiler

condenser and a surge tank. Condensate from the turbine is passed successively through Nos. 1 and 2 heaters and then to the surge tanks. Steam from turbine bleeder No. 1 at 3.97 lb. abs. and from bleeder No. 2 at 16.4 lb. abs. is supplied to these heaters, raising the temperature of the condensate from 78 to 220 deg. F. as it enters the surge tank. The boiler-feed pump suction is taken directly from the surge tank and is forced through the high heat level condenser and No. 3 heater to the boilers at 287 deg. F.

Makeup water is furnished by an evaporator having a capacity of 15,000 lb. per hour. Raw water is supplied from the house tank or from the steam-driven evaporator pump. Steam is supplied from No. 3 bleeder at 63.7 lb. abs. The vapor from the evaporator is condensed in the high heat level condenser and returns to the surge tank. All drains, clean drips and condensate from the heaters are returned directly to the surge tank in which the water level is controlled by a float

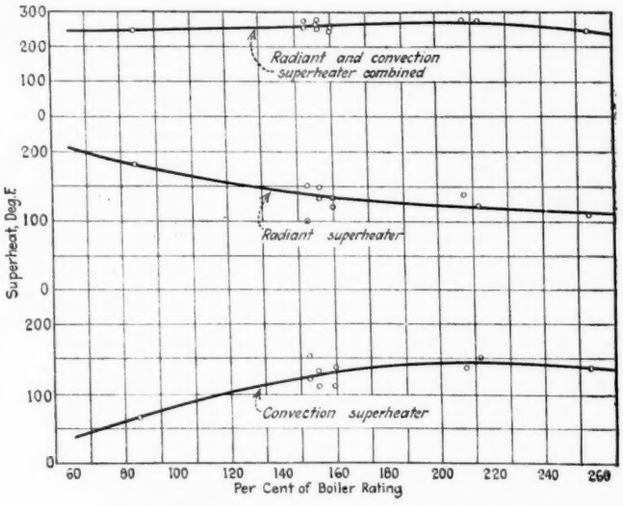


Fig. 6—Uniform temperatures from combination radiant and convection superheater

valve. An excess of makeup water and returns opens the drain line from the surge tank, and the water discharges into two distilled-water storage tanks each of 16,000 gal. capacity. Should the water level in the surge tank fall below a predetermined point, one of the makeup pumps supplies water from the storage tanks. Under normal conditions all units are motor driven, but if a steam-driven auxiliary should be placed in service, the exhaust steam is used in No. 2 heater and No. 2 bleeder is automatically cut out through reverse flow valves.

In the electrical bay there are five floors, the first containing all 440-volt station service buses, remote-controlled switching apparatus, the generator ground resistance room and the generator field resistances. On the second floor are the cable connections from the generator and to outgoing feeders, also the current and potential transformer cell structures. The third floor contains the main and auxiliary 13,200-volt buses and the fourth floor the station control room and battery room. The control boards consist of a benchboard for control of the main unit and feeder switches with separate panels for the mounting of instruments, and a panel board for the control of station auxiliary equipment. Power for station service is stepped down from 13,200 volts to 440 volts through main and auxiliary transformer banks installed outside of the building. All high-voltage equipment and bus structures are designed for operation at 25,000 volts.

The design and construction of the Island Station was carried out under the supervision of Toltz, King & Day, Inc., engineers and architects, St. Paul, Minn., with the co-operation of W. C. Beckjord, chief engineer of the American Light & Traction Co., D. W. Flowers, chief engineer of the St. Paul Gas Light Co., and his assistant, D. R. Putman.

DATA ON PRINCIPAL EQUIPMENT IN ISLAND STATION OF THE ST. PAUL GAS LIGHT CO.

GENERAL

Location	St. Paul, Minn.
Capacity present	25,000 kw.
Capacity, ultimate	100,000 kw.
Engineers and architects	Toltz, King and Day, Inc., St. Paul, Minn.
General contractors	Siems, Helmers & Schaffner, Inc., St. Paul, Minn.

IMPORTANT RATIOS

Based on present capacity

Cost, dollars per kw.	88.7
Cu.ft. of building per kw.	84.2
Heating surface per kw., sq.ft.	1.29
Fur. vol. to boiler surf. (including water screens)	0.694 to 1
Fur. vol. per kw., cu.ft.	0.893
Cond. surf. per kw., sq.ft.	1
Circ. water per kw., g.p.m.	1.44

BOILERS, SUPERHEATERS AND AUXILIARIES

Boilers	Heine Boiler Co.
Type and number	3 hor., cross-drum
Steam gen. sur. per boiler, sq.ft.	10,440
Fur. vol. per boiler, cu.ft.	7,440
Sq.ft. of steam gen. surf. per cu.ft. of fur. vol.	1.405
Arrangement of tubes	19 high, 31 wide
Boiler press., lb. gage	325
Total steam temp., deg. F.	650
Water Screens	Combustion Eng. Corp.
Eff. heating surf. per boiler, sq.ft.	293
Size of tubes	4 in.
Superheaters	Power Specialty Co.
Convection (surf. per boiler, sq.ft.)	2,820
Radiant (surf. per boiler, sq.ft.)	129
Size of elements	1 x 3 in.
Steam gen. to superheating surf.	12.47 to 1
Auxiliaries	
Soot blowers	Diamond Power Specialty Co.
Feed-water reg.	Northern Equipment Co.
Water columns	Reliance Gauge Column Co.

FUEL

Kind	Allegheny Co., Penn.
B.t.u. per lb.	12,350

FURNACES

Type	Air-cooled side and front walls; water screen cooled ashpit; radiant superheater cool rear wall; air-cooled arch.
Firebrick	Evans-Howard Fire Brick Co.
Refractory tile	Evans-Howard Fire Brick Co.
Insulating brick	Celite Products Co.
Suspended arches	American Arch Co.
Furnace casing	Sheet steel

RAW COAL HANDLING EQUIPMENT

Capacity, tons per hour	75
Concrete track hopper, 40 tons; automatic loader; automatic skip hoist, magnetic separator and feeder; double-roll crusher; belt conveyor; automatic self-propelling tripper	R. H. Beaumont Co.
Crushed coal bunkers, steel	3 of 200 tons
Track scale	Fairbanks-Morse Co.

DRYING, PULVERIZING AND COMBUSTION EQUIPMENT

Driers, Lopulco, waste heat	Combustion Eng. Corp.
Drier exhauster, 25,000 c.f.m. at 150 deg. F., 5.5 lb.	Am. Blower Co.
Drive 50-hp., 3-ph. ind. motor	Gen. Elec. Co.
Pulverizers, Raymond, 6-roll, two of 6 tons per hr.	Combustion Eng. Corp.
Drive—100-hp., 3-ph. ind. motor	Gen. Elec. Co.
Pulverizer exhausters—2	Am. Blower Co.
Drive—75-hp., 3 ph. ind. motors	Gen. Elec. Co.
Pulv. automatic feeders—Raymond	Combustion Eng. Corp.
Pulv. coal collectors, two 7-ft. dia., two 4-ft. dia.	Combustion Eng. Corp.
Pulv. coal conveyors, four 12-in. screws	Combustion Eng. Corp.
Drives, one 5-hp., one 10-hp. and two 7.5 hp., ind. motors	Gen. Elec. Co.
Pulv. coal bunkers—steel	4 of 80 tons
Feeders, Lopulco, duplex, 3 per boiler	Combustion Eng. Corp.
Drive each feeder, 3 hp. ind. motor	Gen. Elec. Co.
Burners, Lopulco, 6 per boiler	Combustion Eng. Corp.
Fans, primary air, two	Am. Blower Co.
Drive, two 75-hp., 3-ph. ind. motors	Gen. Elec. Co.
Combustion control	Bailey Meter Co.

ASH-HANDLING EQUIPMENT

Manufacturer	Girtanner Eng. Corp.
Type	Steam jet
Capacity, tons per hr.	10

STACK

Fabricated and erected by	Wm. Bros. Boiler & Mfg. Co.
Type	Steel, brick-lined, self-supporting
Inside diameter at top, ft.-in.	15-6
Height above water screen, ft.	286
Supported on	Building steel

FEED PUMPS AND AUXILIARIES

Boiler-feed pumps	A. S. Cameron St. Pump Co.
Number and type	Two 5-stage and one 4-stage cent.
Speed, r.p.m.	Two at 1,750 and one at 2,000
Drive	Two 150-hp. 440-v. 3-ph. G. E. Ind. motors and one 150-hp. West. turb.
Cap. at 400 lb. press., g.p.m.	300
Feed-pump control	D. H. Skeen & Co.
House service pumps	A. S. Cameron St. Pump Co.
Number and type	Three 2-stage cent.
Size	One 3-in., two 4-in.
Drive	One 40-hp. and one 60-hp., 440-v., 3-ph., G. E. ind. motors and one 60-hp. West. turb.
Cap. at 100 lb. press., g.p.m.	One 250 and two 500
Makeup pumps	A. S. Cameron St. Pump Co.
Type and size	Two 1½-in. 2-stage cent.
Speed and drive	Two 5-hp. 440-v. 3-ph. 1,750 r.p.m. G. E. ind. motors
Sump pumps	
Motor-driven 4-in. vert., cent.; 15-hp. G. E. ind. motor	Morris Mach. Wks.
Steam drive, 8x10½x12-in. duplex	Warren Steam Pump Co.
Water screen and ash sluicing pump; motor driven	Keystone Driller Co.
Feed water heaters, 4 (closed type)	Griscom Russell Co.
Evaporator, 15,000 lb. per hr.	Griscom Russell Co.

MAIN GENERATING UNIT

Manufacturer	West. Elec. & Mfg. Co.
Number	1
Cap. at 80 per cent p. f.	25,000 kw.
Vent. air, cu.ft. per min. at 104 deg. F.	70,000
Speed of unit, r.p.m.	1,800
Steam at throttle	275 lb. gage 650 deg. F.
Auxiliary exciter, steam-driven	West. Elec. & Mfg. Co.
Auxiliary oil pump	West. Elec. & Mfg. Co.
Oil-filtering system (cont. by pass)	S. F. Bowser Co.
Oil cooler, multiwhirl type	Griscom-Russell Co.
Gen. air filter	Midwest Air Filters, Inc.

CONDENSER AND AUXILIARIES

Manufacturer	Westinghouse Elec. & Mfg. Co.
Number and type	One 2-pass surf.
Tube surface, sq.ft.	25,000
Tube dia., in.	1
Material	Muntz metal
Circ. pumps—two per condenser, ea.	18,000 g.p.m.
Cond. pumps, two lb. per hr. at 150 ft. hd.	300,000 and 150,000
Air Pumps—One motor-driven LeBlanc. One duplex LeBlanc steam jet air pump, steam at 125 lb., 650 deg. F.	
Water screens—two	Chain Belt Co.

MOTORS

42 ind. up to 150-hp., total 1,132-hp.	Gen. Elec. Co.
5 ind. up to 150-hp., total 430 hp.	West. Elec. & Mfg. Co.

PIPING, VALVES AND COVERING

High, medium and low-press. steam piping; hot and cold water; circulating water; and air piping	M. J. Dougherty Corp.
Non-return and globe valves	Edward Valve & Mfg. Co.
Gate vales	Chapman Valve Mfg. Co.
Auto. trip valve	Schutte & Koerting Co.
Hyd. operated gate valves	Chapman Valve Mfg. Co.
Atmos. relief, back press. and bleeder valves	G. M. Davis Regulator Co.
Boiler-feed reg.	Northern Equipment Co.
Boiler blowoff valves	Yarnall-Waring Co.
High-press. steam, boiler feed and medium and low-press. lines	Cranelap
Direct-return steam traps	W. H. Nicholson & Co.
Lift and vac. traps	Crane Co.
Pipe covering, steam and water	Fred Sprinkman & Sons Co.
85 per cent magnesia	Ehret Magnesia Mfg. Co.

ELECTRICAL EQUIPMENT

High ten. switch gear	West. Elec. & Mfg. Co.
Low-ten. switch gear	Condit Elec. & Mfg. Co.
Benchboard and panels for h.t. con.	West. Elec. & Mfg. Co.
Panel board for l. t. control	Condit Elec. & Mfg. Co.
Sta. power trans.	Moloney Elec. Co.
Sta. control and emergency bat.	West. Union Bat. Co.
Motor control	Gen. Elec. Co.

INSTRUMENTS

Steam-flow meters	Gen. Elec. Co.
Recording, ind. and int. steam and air flow, flue-gas temp.	Bailey Meter Co.
Recording thermometers and press. gages	Foxboro Inst. Co.
Recording flow meters	Yarnall-Waring Co.
Ind. press. and vac. gages	Am. Schaeffer & Budenberg Mfg. Co. Foxboro Inst. Co.
Ind. thermometers	Taylor Inst. Co., Am. Schaeffer & Budenberg Mfg. Co.
Concentration meter	Esterline-Argus Co.

MISCELLANEOUS EQUIPMENT

Trav. crane, turbine room	Whiting Eqpt. Fdy. Co.
House tank	Pittsburgh Des Moines Steel Co.
Boiler settings	M. Liptak
Coal-weighing app.	Fuller-Lehigh Co.
Station signal system	Payne Dean, Ltd.
Smoke indicators	W. Clansman Co.
Air compressor	Ingersoll-Rand Co.

Small-Town Ice Manufacturing Plant*

By E. F. BURTON

A SURVEY of the small-town ice plants in Indiana was conducted as a part of the Purdue University extension program, with the object in view of bringing the University in closer contact with the industry and of determining ways and means whereby it might be of assistance to the ice manufacturers.

IN STUDYING the conditions in Indiana ice plants, thirty-five plants were visited, enough time being spent in each place to investigate general conditions. No attempts were made to solve individual problems peculiar to each plant, but special attention was given to conditions common to most plants. Five were modern, motor-driven, raw-water plants, six used compression machines driven by steam engines, and the remainder were either absorption or combination absorption and compression plants.

It was found that, as a rule, plants in larger cities were modern and operated at a good efficiency, while those in the smaller towns and communities were more or less run down and used a considerable amount of obsolete equipment.

Horizontal return boilers were most commonly used, because this type requires little overhead room and affords large heating surface in a small space. These boilers cannot be forced beyond their capacity to the extent that can be done with water-tube boilers, so

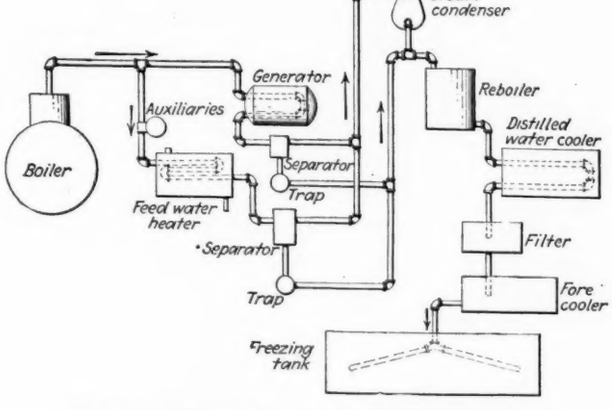


Fig. 1—Typical live steam absorption plant

reserve units were kept in condition to take care of overloads.

The firing in most cases was done by hand, with good results when an efficient fireman was employed. Hand-operated stokers were popular in some places and a few plants used chain-grate stokers. The draft was regulated either by hand or by an automatic damper.

Boilers were set low and too close to the fire. The settings were often leaky and little attempt was made to reduce radiation losses. There was seldom any provision for a flue-gas analysis to determine the losses in the stack.

Steam lines were uninsulated and leaks were found at many joints. Sometimes the steam and return ammonia from the evaporator ran in parallel lines close together, and in one case a steam line and a cold brine line were in contact with each other.

Closed feed-water heaters were used without provision for venting so when the feed water came from a

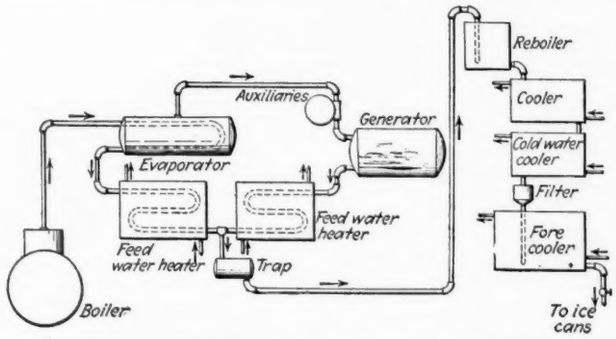


Fig. 2—Exhaust steam absorption system

spray pond the suspended air and oxygen could not be liberated and boiler pitting resulted.

The ammonia compressors were generally of the vertical single-acting or double-acting slow-speed type, either motor-driven or direct connected to a Corliss engine. Most of these compressors and engines had long ago served their period of economic usefulness, but are still repaired from year to year and kept in service.

Machinery of Obsolete Plants

The first generator installed in the state was still in operation and seemed to be giving fairly efficient service. Most of the older plants used multi-tubular generators, while the newer installations used the horizontal shell type. The absorbers were either vertical, horizontal shell type, or double pipe coils.

Traps were not large enough to take care of the condensate from the generator and exposed lines, causing water to back up into the steam coils in the generator. To remedy this the traps were often kept open, allowing live steam to blow through, thus losing considerable heat and nullifying the value of the trap.

In order to "force" the generator, steam was blown through the coils without being condensed. This required a greater amount of steam, because the larger part of the heat content, the latent heat of vaporization, was not utilized.

The ammonia vapor was generally condensed in a set of double-pipe coils where an ample supply of cooling water was available, or in an atmospheric condenser where the water supply was limited. A few submerged condensers were found. Return ammonia lines were uninsulated, except for an accumulation of ice and frost.

Ammonia receivers were too small and were not properly located. Sometimes the ammonia supply in the receiver was inadequate to keep the system charged,

*Abstract of paper read before the American Society of Refrigerating Engineers, New York, Dec. 3, 1924.

†Assistant professor of mechanical engineering, Purdue University.

consequently a vapor instead of a liquid passed through the expansion valve. It was not uncommon to find the receiver in the hottest part of the engine room.

Water was sometimes pumped from deep wells by rotary or lift pumps, but more often by compressed air, making the air compressor an important part of the apparatus. The depth of the air-lift pump in the water well was seldom properly adjusted. Instead of being an economical pumping device, the air pressure was so high that the water was blown from the well.

When air was used for pumping water and for raw-water agitation, one compressor supplied sufficient air at the maximum required pressure. The air necessary for the raw-water system was throttled through a valve to the required agitation pressure, resulting in a loss of efficiency due to the throttling process.

Poor Engineering

In one combination ice-making and cold-storage plant several rooms were used as sharp freezers, where a low temperature was maintained. The refrigerating equipment was a combination absorption and compression plant with the absorption machine serving the ice plant and the compression machine serving the sharp freezers. This was, of course, just the reverse of what it should have been.

In many plants the steam pump and steam engine speeds were controlled by the throttle valve, and in live-steam absorption plants the live steam was reduced in pressure before entering the generator. A throttling process involves a constant heat change, which is always accompanied by a loss of available energy.

Fig. 1 is a diagram of the typical live-steam absorption plant. Steam was generated in the boiler under a pressure sufficient to operate the auxiliary machinery.

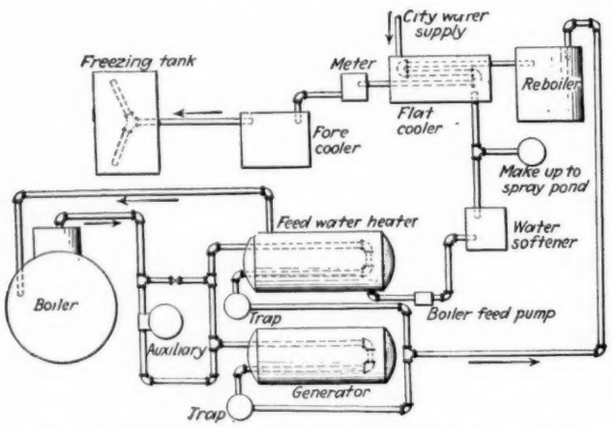


Fig. 3—Water distribution when supply is limited

The exhaust from the auxiliaries was taken through a boiler feed-water heater to a condensate trap, then to the reboiler and skimmer, distilled-water cooler, filter and fore cooler, before delivery to the freezing tank. Live steam from the boiler was usually throttled to a lower pressure before entering the generator. The condensate from the generator follows the same course as the condensate from the auxiliaries. Any uncondensed steam was taken to a surface condenser on the roof to supply additional condensate to the freezing tank.

Fig. 2 illustrates a combination evaporator and exhaust-steam absorption plant. The steam generated in the boiler was used as the heating agent in a secondary boiler or evaporator. The steam generated in the evaporator was used to operate the auxiliary machinery, and the exhaust from the auxiliaries furnished heat for the ammonia generator. The condensate from the evaporator and generator was trapped and taken to the reboiler, cooler, filter and fore cooler, then to the ice cans.

Fig. 3 shows the typical water supply and steam distribution where there was a limited water supply. The

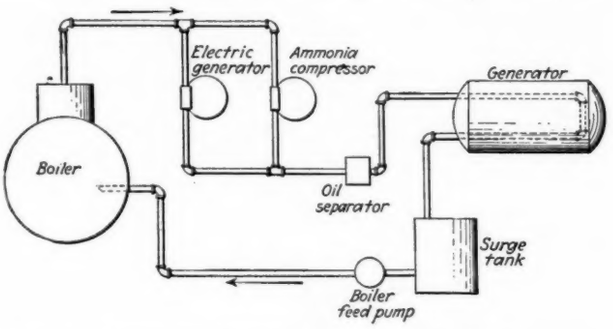


Fig. 4—Steam suggested change to raw-water system

cold city water first cooled the hot distilled water from the reboiler in a flat cooler and went through the water softener to the boiler feed pump which forced it through a closed heater to the boiler. A part of this water went to the spray pond for makeup before going through the softener. The steam generated in the boiler was used to operate the auxiliary machines and the exhaust was utilized in the generator, the condensate going to the freezing tank as before. In case this did not supply enough condensate, a part of the live steam was used to heat the boiler feed water and the condensate from this was trapped to the reboiler with the condensate from the generator.

Suggested Plant Layout

A suggested steam distribution system is to use the high-pressure steam from the boiler to drive an electric generator and an ammonia compressor, as shown in Fig. 4. The exhaust from these will furnish heat for the ammonia generator and the condensate can be taken back to the boiler as feed water. With this arrangement economical steam units can be used to drive the electric generator and ammonia compressor; the several double-acting pumps throughout the plant can then be replaced by small, efficient motor-driven pumps using current from the generator. The feed water can be used over and over again with little fear of boiler scale and consequent troubles.

Another arrangement might be to use the live steam from the boiler to operate a turbine-driven generator, then use the exhaust from the steam turbine in the ammonia generator. This would give a condensate free from oil to return to the boiler as feed water, and the heavy double-acting pumps could be replaced by small motor-driven units, as in the previous case.

The present poor state of the small-town ice manufacturing plant can be attributed to several things. No manufacturer will intentionally operate his plant under unfavorable conditions or at a reduced efficiency unless, of course, the poor operation is due to ignorance.

Some operators delay the purchase of needed equipment as long as possible, because of new developments in equipment and processes. They are afraid that if

they buy new apparatus, something newer and better will soon be developed, making their still new equipment obsolete.

Many operators cannot afford to buy modern equipment. Their product is seasonable and a dull season will often counteract the profits of several good seasons. The equipment is idle for a large part of the year, so that depreciation and interest on the investment is large in comparison with the earning capacity; consequently, much old machinery is kept in use and used apparatus is often installed in order to keep the investment as low as possible.

In order to reduce operating expenses to a minimum, engineers of inferior ability are employed. Most of these engineers were, at one time, erecting mechanics for some manufacturing company, who, after installing the machinery, were retained as engineers. These men are, as a rule, good mechanics, competent to keep the plant in good repair, but they have little theoretical knowledge of refrigeration and mechanical processes and, consequently, seldom maintain the proper equilibrium of operating conditions.

Plant owners and managers seldom know much about their mechanical equipment. They are, as a rule, promoters and business men and do not pretend to know anything of engineering principles. Consequently, they must rely on someone else for advice regarding changes and improvements. This advice can be obtained from three sources—the plant engineer, consulting engineers and the manufacturers of plant equipment.

The plant engineer usually recommends changes that will make his work easier, regardless of beneficial effect upon the plant. He is seldom able to analyze difficult problems and cannot put his ideas across in a manner convincing enough to cause the expenditure of more than enough money to keep the plant going.

A good consulting engineer is able to conduct investigations and recommend improvements, but his fees are usually larger than the average small-town operator can afford to pay. It is also a lamentable fact that so many consulting engineers are connected with manufacturing or distributing companies to the extent that they derive a commission on the sale of equipment recommended by them, and do not give their client an unbiased report on plant conditions. One operator stated that if he used any one of half a dozen consulting engineers, it was a foregone conclusion that he would be advised to replace present equipment with that of another particular make.

The manufacturers of equipment are, perhaps, of the greatest assistance to the ice manufacturer in that they develop new equipment and furnish valuable data necessary for plant operation. Sales engineers are too often salesmen rather than engineers and are not competent to pass judgment on what to buy. To illustrate: Bids were solicited on a medium-sized ice plant. One company, in order to bid under competitors, put the price of the freezing tank to about half of what it should have been and convinced the buyer that he could get just as much ice by freezing it faster. The result was, of course, a poor grade of ice and a loss of efficiency, to the extent that, within a few months, the tank capacity had to be doubled.

It is the author's opinion that the best method of helping the small-town ice manufacturer is to educate the managers, operators and engineers regarding the fundamental principles of mechanical refrigeration and plant operation.

Early Use of High-Pressure Steam

Perkins Steam Generator—Pressures Far Above Present Day Practices—Some Quaint Ideas Held by the Inventor

IN VIEW of the present-day drift toward extremely high steam pressures a recount of the work by Jacob Perkins with high-pressure steam between 1823 and 1840 should be of interest. In 1827 the first licensee of the Perkins unaflow engine, John Penn, of Greenwich, built a twin-unaflow marine-engine for 2,000 lb. per sq.in. with Perkins generators. As a practical worker in superpressures Perkins had experimented with various fluids before going to England, and in a paper on the progressive compressions of water, read before the Royal Society, Jan. 13, 1826, he mentions that his first observations on the liquefaction of imponderable fluids were made in January, 1822. The "Philosophical Proceedings" of 1826 contain a fine engraving of his high-pressure compressing apparatus without need of packing on the plunger, which, he stated, was temporarily limited to 1,000 atmospheres. His "Piezometers" permitted much higher compression. There is also included in the same volume a curve of the pressure-volume relation of water up to this pressure which is remarkable for its resemblance to steam-compression diagrams. All steam engineers should consult these old records of high pressures.

Substituting air for water, he found that air began to condense at 7,350 lb., and that at 17,640 lb. a transparent liquid (liquid air) was seen on the surface of the quicksilver which evidently was used to seal the apparatus. He also gave the results obtained when using several other fluids.

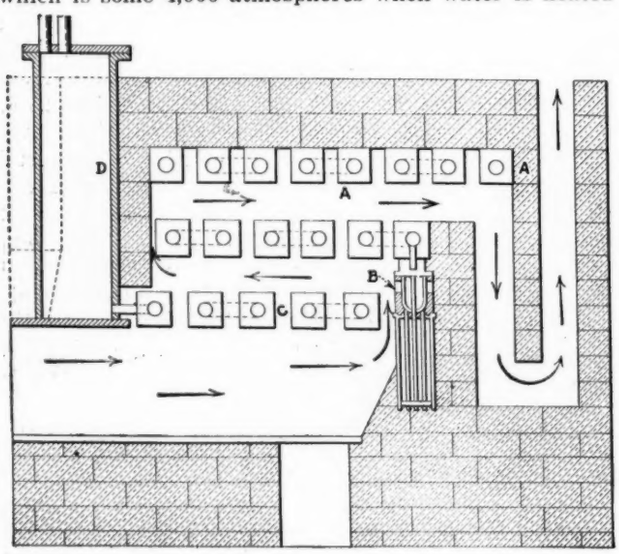
He mentions, in a number of places, the reasonings that led him to conceive of the super compressions of fluids by heat instead of by mechanical power. That he appreciated the advantages of high pressures is evidenced by his statement, "It requires little more heat to generate steam at 50 than at 25 atmospheres." On page 93 of the *London Journal*, 1827, appears an article by Perkins in which he stated:

> In some experiments I heated steam to a temperature that would have given all the power that the highest steam is capable of exerting, which would have 56,000 per sq.in. if the boiler had had its full quantum of water; yet the indicator showed a pressure of less than 5 atmospheres.
>
> Having satisfied myself by repeated experiments as to the certainty of this curious fact, the thought struck me that if heated water were suddenly injected into this highly superheated steam, the effect would be the formation of highly elastic steam, the strength of which would depend upon the temperature and quantity of the supercharged steam, and of the water injected. To ascertain the truth of this theory, I made the following experiment:
>
> A generator was filled with water and heated to about 500 deg. and consequently exerted a force (pressure) of about 50 atmospheres, but as the pressure valve was loaded

to about 60 atmos., the water was prevented from expanding into steam. The superheating tubes were heated to 1,200 deg. A small quantity of water was injected into the generator by the forcing pump, which then forced out, from under the pressure valve into the receiver, a corresponding quantity of water. This (superheated) water instantly flashed into steam; which in the superheater, was at a temperature of over 800 deg. From want of water sufficient to give it the necessary density, the indicator showed a pressure of only 5 atmospheres.

The pump was now made to inject a much larger quantity of water and the indicator then showed a pressure of from 50 to 80 atmos. The throttle valve partly open, the pressure again dropped to 5 atmos. At each pump stroke the pressure was observed to oscillate between 40 and 108 atmos. according to the quantity of water injected; clearly showing at this reduced pressure, that there was a great redundancy of heat (temperature) with little elastic force.

Experience with "rents" in the boiler caused Perkins to remark: "My belief is that water cannot be brought into contact with iron that is heated to 1,200 deg. without a force equal to the maximum pressure of steam, which is some 4,000 atmospheres when water is heated



Cross-section of Perkins' boiler shown in "Dingler's Polytechnische" of 1828

to 1,200 deg. This pressure would, I believe, keep water in contact with iron at any degree of heat, and the steam would then be as dense as the water." That is the present-day problem in the "Atmos" high-pressure boiler.

At this day we may not agree with Perkins' belief that the injection of water into "red-hot" steam would increase the heat capacity of steam. However, he was faced with the need of putting into the engine cylinder as much pressure as possible and, of course, the greater the steam density—that is, the greater the density of the steam in its saturated condition—the greater must be the pressure of the steam in the cylinder at cutoff. It was pressure, not temperature, that Perkins sought —hence his injections.

The further object sought by Perkins was a greater number of expansions and this was obtainable with high pressures. Working on this basis, Perkins built large numbers of extra-high pressure boilers, one of which was used in connection with his simple unaflow engine. The little unaflow engine which was installed at the St. Catherine Docks in 1826 and operated alongside of the great Boulton & Watt low-pressure engines, was supplied with steam at 400 to 700 lb. pressure from a boiler of this staged design.

The accompanying reproduction of an illustration which appeared in the German publication "Dingler's Polytechnische" in 1828 shows that the boiler consisted of a generator *A*, a superheater *C* and a container or receiver *D*. The generator was made up of two tiers of 5x5-in. cast-iron bars having a 1½-in. central hole. These tubes, made in bulk by noted British founders, were placed crosswise in the brick furnace and formed a continuous tube or passage, connected up by end unions. Water was forced into these bars under a high pressure and was held at this pressure until it was highly heated, with the bars exteriorally red hot. There was no steam space in these tubes because they were completely and constantly filled with water. At the outlet-end was placed a heavy loaded relief valve opening into a third row of tubes, which acted as the superheater.

When the boiler-feed pump forced a quantity of water into the already filled tubes, that increase of pressure raised the relief valve and forced out a corresponding quantity of highly heated liquid steam into the superheating tubes, the resulting steam having an exceedingly high temperature (up to 3,000 deg. Perkins found). The pressure in these tubes depends, of course, on the rate at which the steam is taken by the engine. The steam then entered a "receiver," as Perkins called it, or a bomb, and here a quantity of water was then injected into the highly superheated steam. This reduced the temperature through the absorption of heat by the evaporating water. The resulting fluid was hence saturated steam, or steam with less superheat than when in the red-hot tubes.

To avoid misleading *Power* readers into the assumption that might be derived from the preceding that superpressures came to an end with the sequestration of the patent unaflow engine, it is desirable to impress that this was not the case. Superpressures merely dropped to extra-high pressures in a number of other boiler types later made by the Perkins firm in Jacob's time. Neither is it true that when Loftus Perkins, with his working pressure of 700 lb., dropped out by untimely death due to the ammonia-absorption refrigerating process he was engaged in, all his high-pressure legacy disappeared. It was taken over by his acquaintances, who continued the practice, such as the Thorneycrofts, Merryweathers, Yarrow, Brotherwood, Clarkson and many others associated with high steam pressures. In fact, the Loftus Perkins' shops became a sort of club for engineers with advanced ideas on very high pressures.

[Note—The material in this article was collected by Charles R. King, London, Eng., and may be regarded as a continuation of the story of the Perkins high-pressure unaflow engine which appeared in *Power* March 10.—Editor.]

Evaporator Capacities

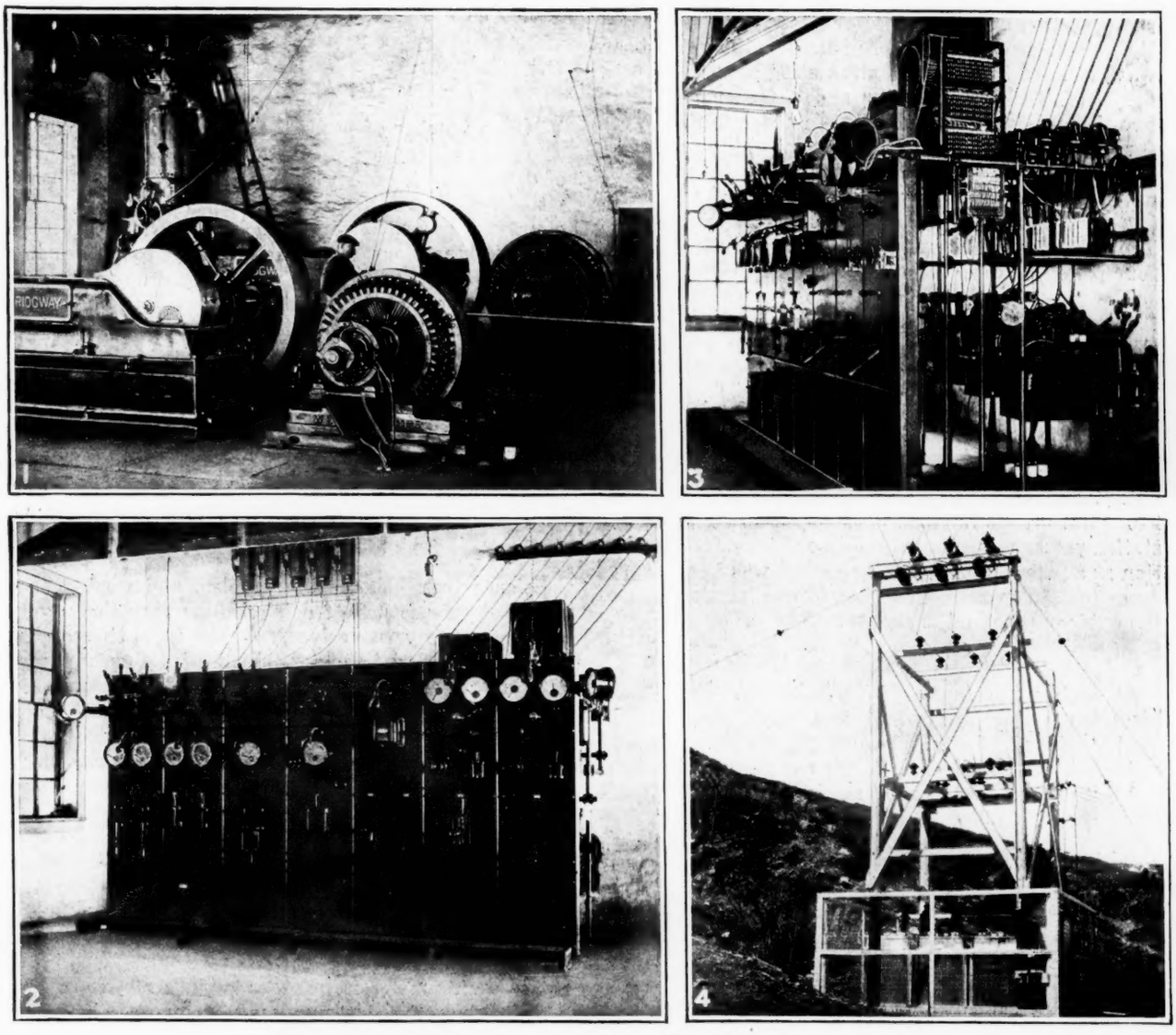
On "Powergraph" page 334 of the March 3 issue the sub-caption accompanying the photograph of the evaporator installation at the Philo station contained the statement, "With a normal capacity of 40,000 lb. per hour, this is perhaps the world's largest power-plant evaporator." This should not be interpreted to mean the largest power-plant evaporator *installation*. The installation in the River Rouge station has a capacity of 150,000 lb. per hour in eight double-effect units, while the Allegheny County Heating Co. installation has a capacity of 100,000 lb. in four single-effect units.

Changing from a Direct-Current to an Alternating-Current System

By Frank Huskinson

A FEW years ago I was master mechanic and chief electrician at a group of mines. There was a steam-electric generating plant, centrally located, which furnished direct current at a potential of 550 volts, for the operation of the mine locomotives, ventilating fans, mining machines, pumps, tipple equipment, shops and town-lighting system. The power-plant equipment consisted of three marine-type boilers and two simple four-valve engines belted to two generators. The switchboard consisted of two feeder panels each with two separate circuits and two generator panels, and are shown on the left, Fig. 2. With the introduction of central-station power into the town it was decided to change from steam-electric power to purchased energy.

At the time of making the change the mines were working full force and the entire change had to be made without interrupting the service. The feeder lines leaving the power house consisted of three No. 4-0 bare-copper wires to each mine, and two No. 4 weatherproof wires for the town lighting system. The latter was so arranged as to have two 260-volt lamps in series, which made it necessary to have at least two lamps burning in the places using this service. The night load



Figs. 1 to 4—Views of power system after changes were made

Fig. 1—Synchronous motors replaced the engines for driving direct-current generators. Fig. 2—Front view of switchboard after extensions were made. Fig. 3—Complete switchboard showing alternating-current control equipment. Fig. 4—Outdoor switching and transformer station.

consisted of the two mine fans and town lights only, this requiring the services of a combination engineer and fireman, and the operation of one of the engines and generator. It was decided to have all outside machinery operated by alternating current. Direct current would thus be used only for the underground equipment.

Motors Replace Engines

Directly in front of each engine the foundation was put in for a synchronous motor that was to take the place of the engines for driving the generators. On these foundations were placed a 200- and a 100-kva. 2,200-volt three-phase synchronous motor, with their pulleys lined up with those of the generators, as shown in Fig. 1. This arrangement did not interfere with the operation of the engines or generators.

The addition of three more panels to the switchboard was made for handling the alternating current—a panel for each synchronous motor and a feeder panel with two three-phase circuits on it. In order to make room for the alternating-current equipment at the rear of the switchboard, it was found necessary to move the original four panels forward a distance of more than two feet, which was done without interrupting service. The three new panels were put in line with the original four panels, making a seven-panel board, Figs. 2 and 3.

The alterations and additions to the feeder lines for the new system were accomplished by lowering the three 4-0 bare-copper wires to each mine to a new crossarm 4 ft. below the old ones. Then three No. 6 bare-copper wires were put in on the top crossarms from the power plant to each mine fan. A third wire was run with the town lighting wires, and five transformers were installed and wired up at different locations in the village and at the shops, reducing the 2,200 volts to 110 and 220 volts for the lighting systems. The central-station power was transmitted to our transforming station at a potential of 44,000 volts, but was here stepped down to 2,300 volts. The transformer station was of the outdoor type and is shown in Fig. 4.

How Motors Were Changed

At each mine fan a 15-hp. 2,200-volt three-phase induction motor was wired and made ready to be quickly slipped into the place of the old direct-current motor, and arranged so as to use the same foundations and belt of the direct-current machine. A 1½-kva. transformer was installed at each fan, reducing the 2,200-volt current to 110 and 220 for lighting service. Similar arrangements were made for changing over the motors on the tipple equipment, the well pump and other equipment being operated by direct-current motors. After all the new feeder lines and circuits had been installed, the original direct-current fan circuit breaker and switch, also the circuit breaker and switch that had been on the old direct-current town lighting circuit, were utilized. The only direct-current motor left in use on the outside was the 50-hp. machine on the box-car loader; as this motor was seldom used and always on the day shift, it was decided to leave it in operation rather than change to an alternating-current machine.

When all was in readiness for the change, the mines were closed down at noon on a Saturday, and by 7 o'clock that evening the generators, mine fans, tipple, shops and town lighting system were working on the new system. The entire system of house lights had to be changed from a series to a multiple wiring; this was done in three days. For temporary service one lamp socket in each series was plugged with a fuse and this allowed the use of the other socket on 110 volts. The new installations were a success, and the operation of the substation now requires only one man, where before it required the services of three high-priced men as well as the part time of several others. The substation is operated only during the day, as the fans, lights, shops, etc., do not depend for their current on the substation operation. The use of induction motors on the mine-fan drives eliminates much of the trouble always experienced with the direct-current machines.

Will Sulphuric Acid Hurt an Oil Engine?

By A. B. Newell

FOR a number of years the burning of a sulphurous fuel in oil engines was known to do a certain amount of damage, which often became manifest in the form of pitted cylinders and valves. Because the action of sulphur was but little understood, all sorts of troubles from sticking rings and scored cylinders to hot bearings and cracked cylinder heads was charged up to its presence, which exists to a greater or less extent in all fuels.

Because anyone could safely say that there would be at least a trace of sulphur in any fuel except a well-refined product, it became a one hundred per cent hole-proof alibi when troubles were encountered that could not be explained in any other way. The fact that it was extremely difficult to obtain a fuel without sulphur at a price nearly approaching that of the fuel containing it made it a problem well worthy of a solution.

Science Solves the Mystery

Science took hold of the problem and worked in a way that science has of doing things very thoroughly, and the mystery was solved. At the same time a good alibi was all shot to pieces. It has been such a good one that it seemed almost a shame to spoil it. At any rate it was worth using in a pinch for a while longer and was—and is, for there still exist a whole lot of people who do not know what the action of sulphur is and how it damages an oil engine. They do not know how this damage may be avoided at practically no expense while burning a fuel of a high sulphur content.

The sulphur that is present in and is injected into a cylinder along with the oil, burns without damaging the engine and is converted into a gas which is harmless just as long as it remains hot and dry. This will be the case unless some condition exists to cause it to cool in the course of its passage to the atmosphere.

All engines that have suffered damage as the result of burning a sulphurous fuel have undergone the detrimental action after they were shut down and allowed to cool; but this does not apply to the air compressor, which will be touched upon later.

The air that an oil engine breathes contains a certain amount of water, which during combustion is converted into superheated steam and expelled along with the exhaust gases; in addition the hydrogen in the fuel unites with oxygen, forming water vapor, or steam.

When the engine cools to a point below the dew point, the steam will condense upon the interior surfaces of

the engine, forming small particles of water, commonly known as sweat. These small particles of water will rapidly absorb any sulphur present in the gases left within the cylinder, and it then becomes dilute sulphuric acid, which is very active on cast iron or steel. When the acid attacks the metal, a soft dark substance is formed, and when this sulphate of iron is removed from the surface of the metal, a small pit will be found.

Should a valve be open when the engine cools, sulphate of iron is likely to form on the seat, and when the engine is again started the valve may leak. If it does, the fire escaping through the opening under high pressure will burn the valve and seat and will cause the cage and surrounding metal to take on a very high temperature, which sets up heat stresses and may cause cracks to develop at points unprotected against such heat by water-jacketing.

However, the pits are generally so small that they will not cause a leaking valve, and when they occur on the interior of the engine, on places such as the cylinder walls, where they are readily discernible, they will be found to be of little consequence.

In one instance an engine had a long exhaust pipe leading away from the engine room to the open air, and the escaping gases cooled to a temperature below the dew point, causing the sulphuric acid to form in the pipe while the engine was running. After a few months the end of the pipe farthest from the engine fell off, having been entirely converted into sulphate of iron. It was found that the portion near the engine which had not had a chance to cool while the engine was running, was in perfect condition.

Stopping the Engine

Since it is only necessary to have the engine cleared of all sulphur fumes before it is shut down and allowed to cool, it is best, before shutting down, to switch onto some refined product such as kerosene which will contain no sulphur. The engine will be thoroughly purged of all foul gases in this way.

Since the air that is compressed in the compressor is raised to a high temperature and must be cooled before going to the next stage for recompression, a condensation is constantly taking place in the cooling coils.

If by any chance the compressor breaths some of the exhaust gases from an engine burning sulphurous fuel, a dilute sulphuric acid will be continuously forming within the cooling coils. When a portion of this passes on to the valves and cylinders, it will immediately attack them and, as the action will be continuous, will soon cause serious damage.

For this reason it is well to lead the breather pipes that conduct air to the compressor to a point outside of the engine room. A simple means of knowing whether the compressor is suffering is to draw off some of the condensate from the coils and test it with litmus paper to determine whether it is acidulous.

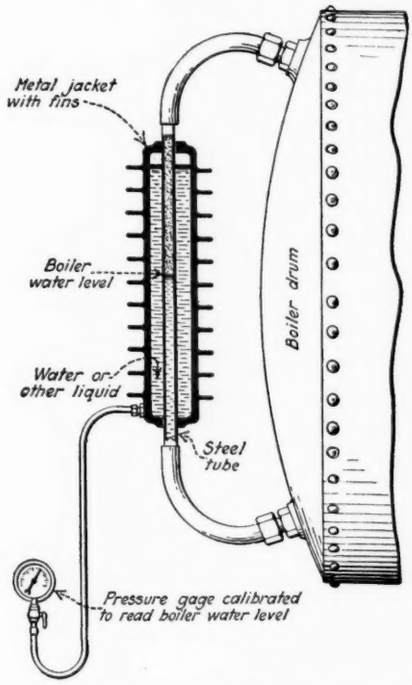
At the present time leading oil-engine builders are paying but little attention to the question of burning a sulphurous fuel, for they know quite well that its action is not of a serious nature.

"The explosion of a steam boiler is not an accident," says Livingston Saylor, chief, boiler section, Bureau of Inspection, Pennsylvania, "and is always preventable. It proceeds from a cause which might have been foreseen, and the defect could have been remedied and the explosion prevented."

Glassless Gage Glass

One of the problems that has been worrying the designers of boilers for extremely high pressures is the necessity of indicating the water level in a positive manner. Gage glasses of the ordinary type are not considered suitable for boilers carrying pressures around 1.000 lb. per sq.in. There are several possible solutions for this problem. Most of those so far announced have a manometer or other pressure gage operated by the hydraulic head of the water in the boiler drum, the effect of steam pressure being eliminated by a balancing line connected to the steam space.

A fundamentally different solution to the same problem seems to be offered in the British patent 225,035 by G. and J. Weir, Limited, Cathcart, Glasgow, and the Right Hon. W. Douglas. As will be seen from the accompanying sketch, the ordinary gage glass is



Vapor pressure of jacket liquid varies with boiler-water level

replaced by a metal tube that is surrounded by a metal jacket with fins, the annular space being filled with water or other liquid. The temperature of this liquid must rise or fall until a balance is reached between the heat radiated from the fins and that received from the steam and water in the inner tube. The temperature at which this balance occurs will depend upon the water level in the inner tube, because heat passes more readily from the steam-filled portion than from the portion filled with partly cooled water.

Each temperature of the outer liquid has a corresponding vapor pressure, which may be recorded on a distant gage. This gage can be calibrated to read directly in terms of water level. If desired, the pressure in the space between the tube and jacket can be used at the same time to operate a boiler feed-water regulator, high- and low-water alarms, etc. It will be noticed that the principle of operation is similar to that used in a well-known American feed-water regulating device, which, however uses an inclined tube.

Feed-Water Regulation

Modern Boilers Require Close Feed Water Control—Character of Load Determines Method To Be Used—Typical Modern Regulators

By CHARLES L. HUBBARD

WHILE boiler feeding has always been an important detail of plant operation, the necessity for giving it greater attention has been brought about by radical changes in boiler design and operation.

Before the advent of central-station power, plants that were operated in connection with factories, were equipped with fire-tube boilers having a large water capacity. These were operated under a nearly constant load, and when more power was required, as in putting into operation another department or throwing on the lighting load, an additional unit was put in service, conditions on the other boilers being maintained as before. Under these circumstances it was desirable, and comparatively easy, to hold a constant water level by adjusting the feed-pump delivery. In smaller plants and those less carefully operated, the feed pump was more likely to be run intermittently, the aim being to keep the level within the high and low limit necessary for safety.

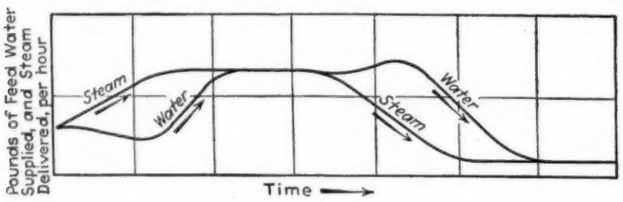


Fig. 1—Water flow rate follows rate of steam flow

Effect of Fluctuating Loads

Modern practice makes extensive use of water-tube boilers having a small water capacity compared with their steaming capacity, so that the water supply must closely follow the steam demand through all load fluctuations. Furthermore, demands for power and methods of operation have greatly changed in recent years. While the steady load still exists in many kinds of manufacturing plants, widely fluctuating loads are found in central stations and in many of the industrial plants. For example, at the Chicago By-Products Coke Co., 3,000 sq.ft. of waste-heat boilers operate under a load that varies from zero to 200 per cent in three-minute cycles, while in a mine headhouse of the Philadelphia & Reading R.R. Co., a battery of boilers is operated with a load ranging from zero to 250 per cent in three-minute cycles.

In office buildings the load fluctuates widely owing to elevator and lighting demands, and in factory plants the load varies considerably at different seasons of the year. Where formerly an extra boiler was cut in at times of peak load without changing the general operating conditions, it is now customary to take care of these temporary fluctuations by forcing the boilers already in use. It is evident that the older methods of boiler feeding must be radically changed.

Assuming the new standards of boiler design and operation, there is one condition that must always be carried out to secure the best results and that is a *continuous* feed, although it is not always desirable to have it uniform. Continuous feeding is necessary to avoid checking evaporation by admitting large volumes of cold water at one time. Although the feed may have a temperature ranging from 200 to 210 deg., the boiling water will have a temperature of 388 deg. for 200 lb. pressure, so that the former may be considered cool by comparison.

Water softeners are designed for a given capacity at a certain continuous rate of flow, and if this action is made intermittent, a larger apparatus must be provided.

When the velocity through a feed-water heater or economizer is reduced below a certain point, the feed may reach a sufficiently high temperature to vaporize and so cause water hammer and other operating difficulties. On the other hand, too high a velocity at intermittent periods, will result in a temperature below that necessary for economical operation.

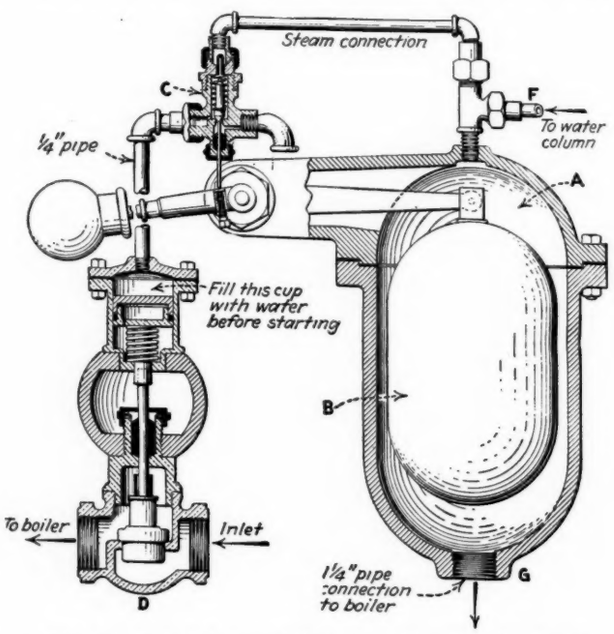


Fig. 2—Regulator maintains constant water level

If the load is constant or the changes very gradual, the rate of feeding should parallel the demand for steam, so that a constant water level will be maintained in the boiler. When the load fluctuates more or less, the feed supply should still follow the steam requirements, but at a distance depending upon the

rapidity of change and the amount of variation. For small and medium changes, the feed supply should lag behind the steam demands for a time, and then gradually catch up and pass it, so as to bring the water level to the normal point within a reasonable time after the

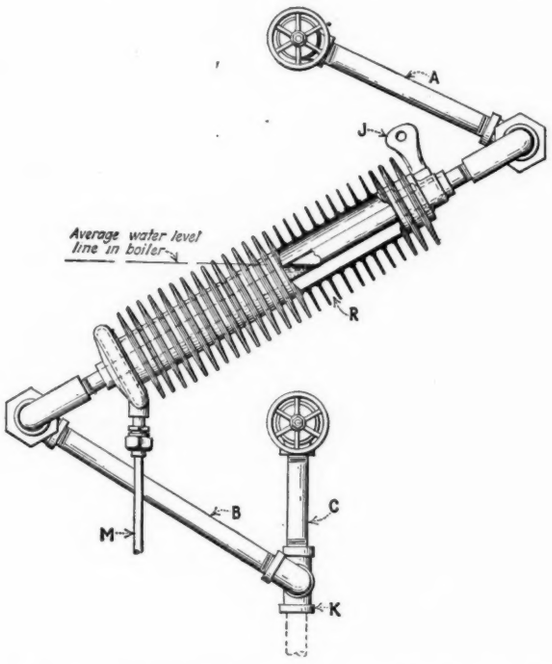


Fig. 3—Regulator by proper adjustment will act independent of sharp load fluctuations

load has become stabilized. When the load increases, and there is a demand for more steam, the furnace should be given time to catch up before feed water is supplied.

Water Introduced as Needed

All the heat of the furnace should at first be given to the generation of steam and the water level allowed to fall somewhat during this process. After the furnace conditions have been brought to a point where the heat generated exceeds that required for evaporation alone, the rate of feeding may be gradually increased until the temporary deficiency has been made up, after which the supply should be cut down to a point where it just equals the demand for steam. When it is necessary to increase the steam output very rapidly, the rate of feed supply should even be reduced temporarily, thus giving the boiler a better chance to meet the sudden steam demand and relieving the furnace of the necessity of warming the water up to the boiling point.

On the other hand, should the load suddenly drop off after a high load period, it takes some time for the furnace to slow down to where it generates heat in proportion to the new load condition. In this case it is desirable to increase the rate of feed for a short time, in order to absorb the extra heat generated by the furnace during this brief period. In plants, therefore, where the load fluctuates considerably, it is best to vary the working water level in the boilers as much as the design will safely permit, and use this variation of water volume as a sort of compensating governor. With this method of operation the rate of feed would be temporarily decreased on sudden demands for more steam, and maximum loads would be carried at or near the lowest permissible water level. Sudden drops in the load would call for the reverse of the foregoing, in which case the rate of feeding should be temporarily increased and the water level carried at the highest point with a minimum load.

Correct Method of Feeding

Between these extremes the proper method of feeding will vary according to operating conditions, to a uniform rate and constant water level for a steady load. The possibilities of this method of feeding are brought out by a report of tests made by the American Electric Railway Association, which states that the water contained in the drums of an ordinary 5,000-sq.ft. water-tube boiler is sufficient to supply the full rated capacity for five minutes with a fall in water level of only one inch, without other feed supply.

The effects of temporarily reducing the feed supply as the steam demand increases, and vice versa, are shown graphically in Fig. 1.

It should be borne in mind that the water level in a boiler may vary perceptibly without change in the actual quantity or weight that it contains, and further-

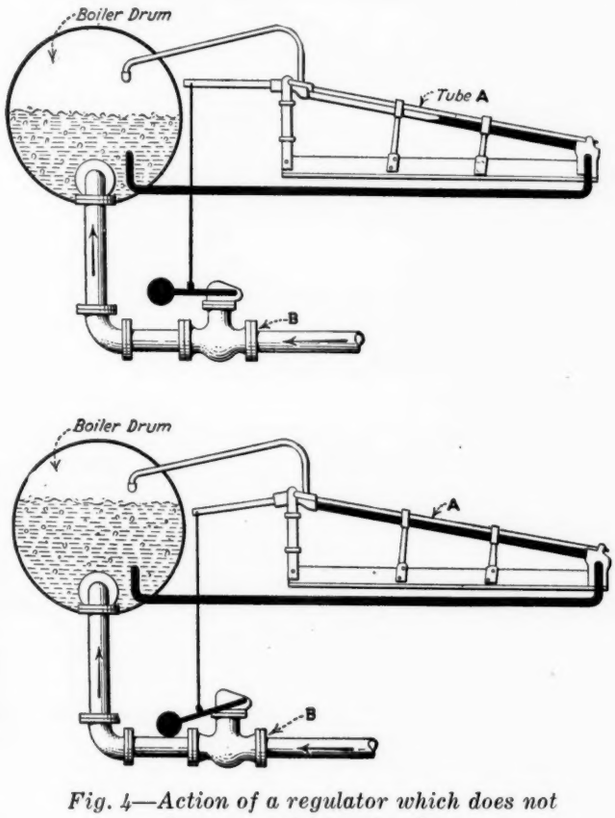


Fig. 4—Action of a regulator which does not have a constant water flow

more, it may stand at different levels in different parts of the boiler. This is due primarily to a variation in temperature, which not only affects its density, but where boiling is taking place, the height of the level is increased by the large quantity of rising steam bubbles.

In practice the level due to the actual volume of solid water is called the "weight level" and that due to the volume of mixed water and steam, the "volume level." When the entire quantity of feed water is

delivered at one side of the drum or boiler, the level will be somewhat lower on that side than on the other, where it is lighter, because of its higher temperature, and where rapid ebullition or boiling is taking place. For this reason two gage glasses and two regulators are required in very large boilers to indicate the level and distribute the entering water properly.

Automatic regulation of the rate of feed is much to be preferred in the average case to hand feeding, and in large plants, carrying rapidly and widely fluctuating loads, it is practically impossible to follow these changes by hand manipulation of the feed valves.

Automatic Regulation

Any system of automatic feed regulation consists of two essential parts: (1) That controlling the valve in the feed line to the boilers; (2) that controlling the steam supply, by means of which the speed of the pump is varied to meet existing conditions at the feed valve.

While there are various devices on the market for automatic feed control, they are divided into two general classes, one of which is adapted to the maintenance of a practically uniform water line regardless of changes in load or other operating conditions, while the other is designed to fulfill the requirements involved in operating a variable water level.

A constant level regulator is shown in Fig. 2 and consists of a chamber *A* connected at the bottom with the boiler, below the water line, and at the top with the steam space; in practice these connections are usually made with the regular water-column fitting.

Inside chamber *A* is a weight or displacement body *B* connected by means of weighted levers with a small actuating valve *C*. The controlling valve *D* is placed in the feed line to the boiler and is connected with the actuating valve by a small pipe, as shown. When the water level falls so that the end of pipe *F* is uncovered, steam is admitted to chamber *A*, thus displacing the water within it and causing the weight *B* to fall sufficiently to open valve *C* and exhaust the steam pressure from the piston above valve *D*. The valve *D* is then opened by means of the coil spring, and water is admitted to the boiler.

Constant Level Control

In actual operation the steam and water connections with the water column are made so close together that the necessary variation in water level required to operate the device will not exceed one half inch. Other regulators designed upon the same general principle make use of floats instead of a displacement weight, and are so constructed that the feed-control valve assumes a position that supplies just enough water to meet the existing requirements at the given time, instead of completely opening and closing each time the low or high limit is reached.

The regulator in Fig. 3 consists of a water tube passing through a small generator *R* provided with fins. The water tube is connected with the steam space in the boiler by the pipe *A* and with the water space by the connections *B* and C. The level of the water in the tube is then that existing in the boiler. The generator *R* is partly filled with water, and the steam in the water tube causes an evaporation of part of this water, which exerts a pressure on a feed-water regulating valve through the line *M*. If the boiler-water level decreases, more of the water tube is filled with steam and the greater heat absorption causes an increased pressure in the generator which serves to open the feed valve wider. By variation in the fins, which radiate much of the heat absorbed by the water in the generator, sharp and short variations in the boiler steam demand will not affect the feed control.

The device illustrated in Fig. 4 is for maintaining a variable water line, within safe limits, which are fixed by the design of the boiler to which it is attached.

Referring to the drawings, *A* is an inclined metal tube connected at the lower end with the boiler drum below the water line and at the upper end with the steam space. This tube is so mounted and connected that changes in its length, due to expansion and contraction, are communicated with the feed valve *B* and so vary the rate of feed to the boiler.

Water Level Changes With Load

The upper drawing shows the apparatus under normal working conditions, with the water level standing at the center of the drum and of the tube, in which case the length of the latter is such as to open the feed valve just enough to maintain a uniform water level at constant load.

Suppose there is a sudden demand for more steam. The furnace is forced, and the rapid increase in ebullition fills the water with steam bubbles, thus increasing its volume and raising the level as shown in the lower drawing. This fills the tube with comparatively cool water and causes it to contract and so close the valve *B*. If the high load continues, the water level will gradually fall, owing to evaporation, until a point is reached where the valve *B* will begin to open. This will continue until a uniform rate of feed is reached which just equals the steam discharged from the boiler. A heavy load calls for a maximum supply of feed water, which can be obtained only by a large opening of valve *B*, and to obtain this it is necessary for the level to fall to its lowest limit, which is the most desirable condition for heavy loads.

The Evaporator in a Small Power Plant

By A. G. Christie*

Probably one of the earliest discussions in *Power* of the use of evaporators in stationary power plants is an article on "Distilled Makeup Water" in the issue of June 9, 1914. This article refers to some remarks made by J. W. Parker, of the Detroit Edison Company, concerning their Delray Station. Mr. Parker stated that they were considering the use of distilled makeup water for that plant. The concluding paragraphs of the article are:

> Whether distilled makeup water will be advantageous or disadvantageous in such plants remains to be proved by the results of its use in some of the plants now contemplating it.
>
> The first thought that comes to one considering it is that it has been used in marine practice for years without giving really serious trouble. The cost of distilling makeup water is not an important consideration for, even in extreme cases, the quantity of water will not exceed 15 per cent and in well-conducted plants, where leakage is closely watched and minimized, it will be as low as 5 per cent.

This early article makes interesting reading now,

*Professor of Mechanical Engineering, Johns Hopkins University.

when evaporators are used in most of our large power stations and where improvements in station operation have cut makeup down to 2 per cent or less. It is worth noting that evaporators were first installed in the large central stations where their use resulted in better station performance.

Small Plant Evaporators a Later Development

Interest in the use of evaporators in small power plants did not develop until several years later. *Power* on March 21, 1922, commented editorially on "Evaporators in Small Boiler Plants," urged their more extended use and stated the requirements for such evaporators. This editorial pointed out certain gains that might be expected from the use of an evaporator in the small boiler plant.

During the fall of 1922 the Johns Hopkins University purchased a No. 6 vertical Reilly low-pressure evaporator of the submerged type with a maximum capacity of 2,000 gal. per 24 hours, and this was installed in the University Power Plant at Homewood in the early part of 1923. It was used experimentally by students for the rest of the college year. During the following summer certain changes were made in the plant and storage tanks for makeup water were provided. The evaporator was piped up as shown in the accompanying sketch.

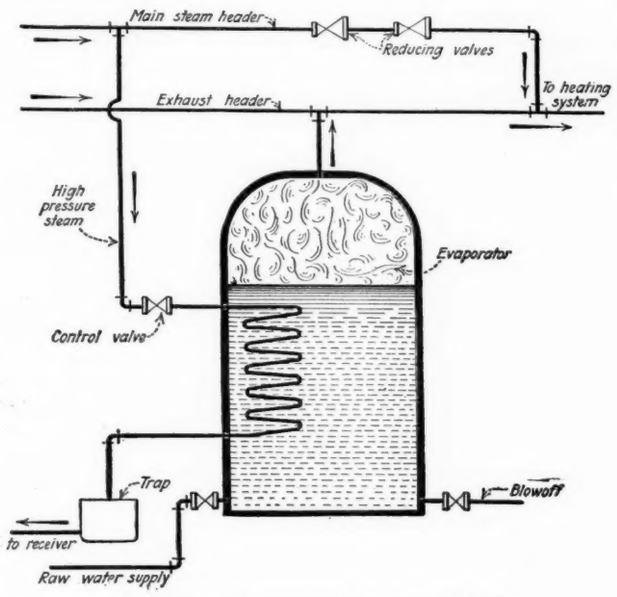


Diagram of evaporator connections

Heating System Acts as Evaporator Condenser

The demand of steam for heating, cooking, etc., in the dormitories and University buildings during long periods each day greatly exceeds the amount of exhaust steam from the turbines furnishing power to the University system. Hence high-pressure steam must be added to the heating system through reducing valves at such times. The evaporator was so connected that it took high-pressure steam from the main header and delivered low-pressure steam as makeup to the heating system, thus reducing the amount of steam passing through the reducing valves during periods when the exhaust steam was not sufficient to meet the demand. It had been noted in earlier years of operation that condensate seemed to hang up in the radiators, when steam was turned on cold buildings in the early morning, and that it did not return freely until an hour or more later. This occurred in spite of the fact that a high-grade vacuum system of heating was in use. It was usually found necessary to add raw water makeup to the boiler feed before the returns were equal to the boiler-feed demand. When shutting down at night, the condensate returns would exceed the demand and some would waste to the sewer. This was corrected by the installation of large condensate receivers so that the makeup has been reduced to a small amount, and this can readily be supplied by the evaporator when operated in the manner just outlined.

Only two 2,640-sq.ft. water-tube boilers have been required to carry the whole load up to the present time. These are provided with under-feed stokers which frequently have to operate at 200 per cent rating. Although 150 lb. can be carried during laboratory periods, the usual boiler pressure is 125 lb. Before the evaporator was installed these boilers were blown down twice a day. During the summer months the boiler inspector would require all the tubes to be turbined and the drums scraped. The scale was softened by pouring kerosene into the boiler while still warm after it had been taken off the line. This boiler cleaning usually cost about $225 each year.

Results Have Justified Installation

The evaporator was in service throughout the whole college year 1923-24. Boiler blow-down was reduced to once a week. The evaporator is blown down once a day and the scale is cracked once a week.

Last summer the inspector found the boiler tubes clean and the drum in good shape with no indications of pitting. There was no need of using the turbine in the tubes, and the boiler was closed up after brushing the drum with a cement wash. No compound is used at all.

The first cost of this small evaporator, completely installed with piping, was about $450. Its use, as indicated, has resulted in a direct saving in the cost of cleaning boilers and in the cost of boiler compounds. Since the tubes remained clean throughout the year, it must also have effected a material saving in fuel, for the resultant boiler efficiency must have been higher than it would have been with scaled tubes. It would appear that the evaporator will pay for itself in two or three years. The evaporator has proved a simple machine to operate and certainly is justified even in this small plant.

As a result of these experiences with an evaporator in a small boiler plant, the following advantages may be expected from its use:

1. A saving in the cost of boiler compounds.
2. A saving in the cost of labor, gaskets, tools, etc., in cleaning boilers.
3. A saving in fuel through less frequent blow-down of boilers.
4. A saving of fuel through higher boiler efficiency as a result of clean tubes.
5. A reduction of boiler outage and less danger of damage from overheated tubes at high boiler ratings.

The arrangement and operation of this small evaporator have been described in detail, for it is felt that a similar unit could be installed in many another small plant and that even larger savings might result from its use.

Economizer Corrosion and Dew Point of Flue Gases

By B. M. Thornton

With the present-day practice of high-pressure power plants the design of boilers, superheaters and economizers has undergone radical changes. Steel-tube economizers are now becoming standard practice in modern power plants. Unless proper precautions are taken, however, steel-tube economizers will give trouble with both internal and external corrosion.

Internal corrosion is now generally admitted to be due to oxygen present in the feed water. Analysis of internal deposits in one case showed 92 per cent iron oxide, the oxygen content in cubic centimeters per liter being 2.80 at the inlet and 1.54 at the outlet of the economizer. By passing the feed water through a deaërator, or heating for a sufficient time in an open heater, most of the oxygen may be removed and the corrosion reduced to a practically harmless amount. Makers of steel-tube economizers recommend, where possible, an inlet temperature of over 200 deg. F. in order to minimize internal corrosion; and with this temperature little trouble is likely with external corrosion.

External corrosion is caused by the action of acid. Fuels that contain a high percentage of sulphur form sulphur-dioxide in combustion which will unite with any moisture present to form sulphurous and sulphuric acids which sometimes attack the metal violently. The moisture may come originally from outside the economizer, through the roof, or from leaky valves and fittings; or it may come from the furnace through leaks in the boiler or superheater. Most commonly, however, corrosion is caused by the condensation of the steam formed in the combustion of the fuel, and that introduced with the air. For a fuel requiring 16 lb. of dry air for combustion, with 60 per cent relative humidity and a boiler-room temperature of 90 deg. F., 0.3 lb. of water will enter the furnace with each pound of fuel burned, and it will be seen that with an average fuel the weight of steam leaving the furnace may easily exceed 50 per cent of the weight of fuel fired. At constant pressure the dew point of the gases is dependent on the weight of steam and gas formed per pound of fuel, which means that it will vary with the excess air.

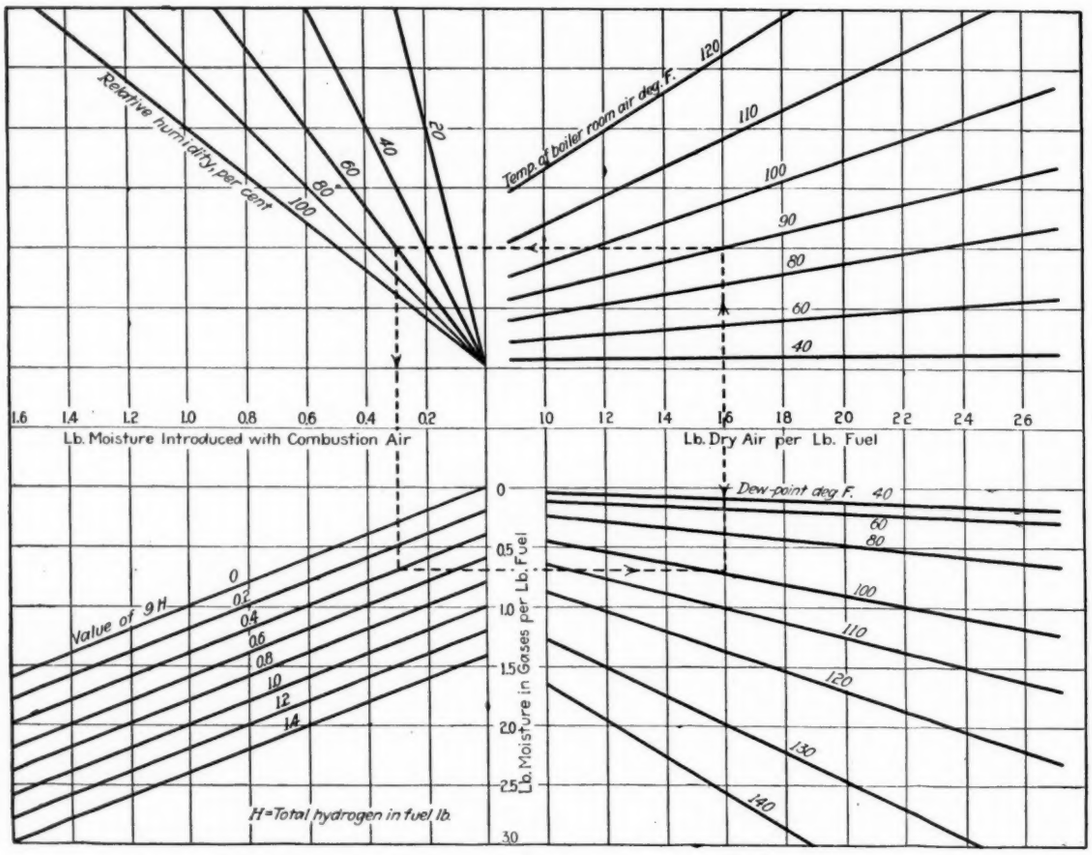
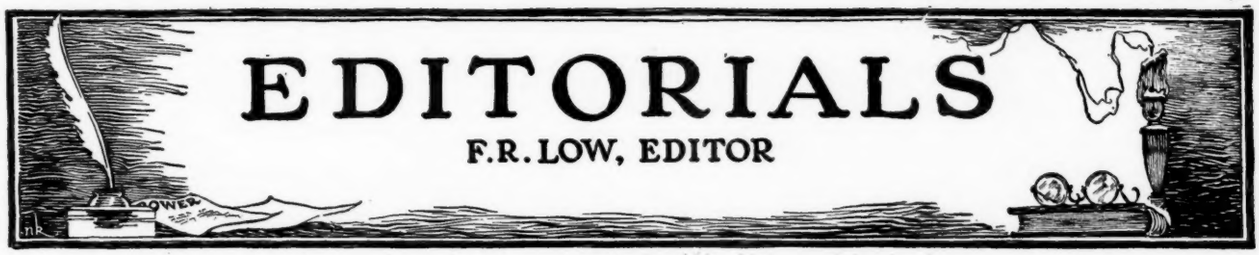


Chart giving dew point of flue gas at atmospheric pressure

In order to simplify the rather troublesome calculation of the dew point, the chart shown has been prepared. Knowing the analysis of the fuel and the relative humidity and temperature of the air, the dew-point is readily determined. It should be noted that the dew point will vary slightly with the amount of non-combustible matter in the coal; the variation with widely different fuels is, however, too small to be of any practical importance. The chart has been drawn for a 15 per cent total of moisture, nitrogen and ash.

It is apparent from the chart that with proper operating conditions condensation on the economizer elements is not likely to occur except when starting up from cold. With the high value of 1 lb. of total vapor and 14 lb. of air per pound of fuel, the dew point is 114 deg. F., and to avoid condensation the tube walls should have a temperature at least equal to this. It is good practice to have an initial feed-water temperature of at least 120 deg. F.



Disinterested Propaganda

HARDLY a week goes by without the launching of some movement of the type termed propaganda. Usually, these movements are anything but disinterested and the idea, however meritorious, is associated in the public mind with profit seeking.

Propaganda, however, can be of the constructive type whereby real valuable service is performed to the advantage of the community at large. Such is the Gas and Oil Power Week now being promoted by the American Society of Mechanical Engineers, the Chemical Society, the Petroleum Institute and a score of other engineering and technical organizations. Plans have been perfected for the holding of meetings during the latter part of April in some ninety cities. While oil engines will be the subject covered at many of the meetings, the basic topic is petroleum. Methods of increasing the well output, improved retorting methods and more economical utilization of the liquid will be thoroughly discussed by leading men in the industries.

Engineering Students

IN A recent issue attention was called to the fact that the Society for the Promotion of Engineering Education had undertaken an extensive investigation of engineering education "as is," in order to provide a foundation for intelligent planning.

Already information of value has been collected. Writing in the March issue of the *Journal of Engineering Education*, H. P. Hammond, Associate Director of the S. P. E. E. investigation, summarizes findings which are somewhat disquieting and for that reason particularly useful. All is not well if, as reports from all parts of the country indicate, there has been a steady decline in the fundamental training of students entering college. Deficiencies in mathematics and English appear to be particularly widespread.

At the present time, on the average, of every one hundred engineering students who enter regularly and pursue regular courses, sixty-two begin the sophomore year, forty-three the junior year, thirty-three the senior year and thirty graduate regularly with their class. In former days a noticeably higher percentage finished. However, these figures may have been influenced by other factors than the one under consideration.

Of more definite significance is the almost universal report that the freshmen show not only a lack of adequate training in algebra and other subjects, but a general inability to think things through for themselves. For this serious state of affairs the college instructor blames the high school. It seems that the high schools, in attempting to replace the college to some extent for the ninety per cent of its graduates who go no further, are not giving the other ten per cent a solid foundation for engineering study.

The old idea of studying for discipline has been largely replaced by the desire to broaden high-school education. This must be done with caution. Undoubtedly, some parts of the old curricula, formerly defended on the grounds of mental discipline alone, can profitably be given up, but discipline should be retained by requiring a mastery of certain subjects fundamental to the student's future study and work. For the would-be engineer algebra and geometry certainly fall in this class and should be the subject of thorough drill. Moreover, in the study of these subjects the student should be compelled to reason things out, not merely to memorize. A good parrot makes a mighty poor engineer.

Interconnection Activity

ALMOST daily the press continues to announce new issues of public-utility securities in large blocks and in many cases the formation of new holding companies. Aside from attesting to the popularity of public-utility investments this may be taken, in a measure, as an indication of increased construction. Underlying this activity is the process of interconnection now going on, crystallizing the idea put forward a few years ago by the slogan "Superpower." In this work it has been found desirable in many cases to reorganize existing companies or form new ones in order to attain the degree of flexibility necessary to unified control of operation.

The process is more or less in a state of flux, and the picture is still too close to hazard an opinion as to the ultimate outcome. However, from an engineering point of view there are certain definite aspects to be noted. In the first place, it provides a better system diversity and should insure greater reliability of service. It will also react to the benefit of the smaller station companies in providing greater stability, increased resources for improvements and place at their disposal a broader engineering experience than heretofore attainable. For these reasons the small station managements should welcome the idea.

Liquid Fuel Supply

WHILE wastefulness is as deplorable in the petroleum industry as elsewhere, the present agitation for better methods should not be taken as a warning that the world will shortly find itself without a liquid fuel.

Statistics of the oil industry may be juggled to prove any view. The steady decrease in production over long periods and the increasing consumption are used by one to paint a discouraging picture of petroleum's future; the discovery of the Los Angeles basin and the Wortham pool are used by another to show that new flush production can be found to bolster up the steady decrease in known fields. However, the one stubborn fact is that oil in the ground, like ore in the mine, is

a wasting asset and that there will be at some time a definite end to the supply.

This should not be taken as disquieting news, for even if all the petroleum pools now known and unknown became exhausted, the supply of liquid fuel would still be sufficient to meet the world's demands for upward of two thousand years.

In a consideration of oil supply entirely too much stress is laid on petroleum to the practical exclusion of shale oil from the inventory. That oil can be produced from shale and put on the market at a profit is indicated by the operation of the Scottish shale mines and more recently by the success of the Catlin plant at Elko, Nev. There is also at least one plant in commercial operation in Colorado. These undertakings are competing with petroleum oil, and whenever crude petroleum reaches an average of two dollars a barrel the shale industry will have an opportunity to show activity, as the cost of mining and refining is somewhat under two dollars. The quality of the oil equals that of the ordinary petroleum, and it is possible to obtain light distillates directly from the shale.

Shale is of especial interest since it is found in almost all parts of the world. In this country the known deposits occur in the majority of the states, appearing east of the Appalachian Mountains, in practically all of the Central West as well as in the Rocky Mountain States. Unlike many natural resources, its use will not be handicapped by costly transportation charges to the consumer.

The cost of developing a shale deposit will be much less than the cost of developing and covering a petroleum pool, while production can be more easily synchronized with the market demand. Some twenty to one hundred gallons of oil may be recovered per ton of shale, and the refuse is claimed to make an ideal road material, containing enough of the bitumen to act as a binder.

A full examination of the situation will do much to relieve the uneasiness among oil consumers.

A Power-Factor Clause Part of an Equitable Rate

AN EQUITABLE rate for electric power and light service has attracted the attention of some of the ablest minds in the industry, but the result so far has only been a partial solution of the problem. Any rate, to be fair to all classes of consumers, must be equitable; that is, it must make each class bear its just share of rendering the service. At first thought this might appear as a somewhat simple matter, but when all the influencing factors that enter into a cost-of-service rate are considered, the problem becomes very complicated. This is made more involved, since a number of the factors are not readily evaluated.

In an alternating-current circuit power factor should be considered in rate making; in fact, no rate can be equitable unless it is considered. But, strange to say, in many cases it is avoided entirely and in others, where power-factor clauses have been introduced in the rate, they have not been enforced. However, power-factor clauses are being successfully enforced in power rates, therefore their use today is no experiment, but rather the result of mature consideration and application. This fact makes the lack of a more general enforcement of power-factor clauses seem somewhat paradoxical, especially in the light of the vast amount of discussion and effort given to arriving at an equitable rate.

To arrive at an absolutely fair charge for low power factor in a power rate is probably as involved as determining a rate on a cost-of-service basis. Neither is possible if the last degree of refinement is to be obtained. Whether the rate is absolutely equitable or not, it is something that must be part of the power business and should be made on a cost-of-service basis as closely as is humanly possible to do so, consistent with simplicity. So it is with a power-factor clause, which should be part of a rate for alternating-current power service; it should be made to represent, so far as possible a fair charge for the increased cost of service caused by power factors below an established standard.

The amount of electrical system capacity required to supply a given load varies almost directly as the power factor of the load. It requires more than double the generator transformer and line capacity to supply a one-hundred kilowatt load at fifty per cent power factor that is required at unity power factor. In such a case the power losses in the system would be four times as great at the low power factor as at the high. If two such customers are allowed to pay the same rate, it certainly is not equitable, and is unjust to the one who has the high power-factor load, not considering the fact that he is also subjected to some of the bad effects of the low power-factor load.

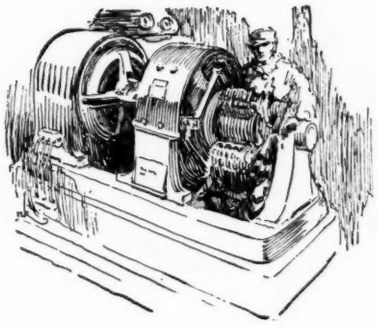
Power factor is fundamentally part of alternating-current transmission of energy and therefore cannot be neglected. It must be considered in any system of rates if it is to be equitable for this class of service. It is not only of interest to the power companies, but every customer that has a high power-factor load should be vitally interested, since if there is not a power-factor clause in the rate, this class of customer is being discriminated against and made to pay more than a fair share of the cost of the service rendered. This lack of such a clause in a rate encourages uneconomical practice on the part of consumers, which are reflected directly as an unnecessary waste of our power resources and should be discouraged.

Evaporators in Small Plants

IT SEEMS reasonable to suppose that many readers will find a tip of real dollars-and-cents value in Professor Christie's article, "The Evaporator in a Small Plant," on page 458. One objection sometimes raised to the use of an evaporator is that it "degrades" the heat which it uses; that is, though it returns the heat to the system, it does so at a lower temperature, thereby sacrificing some opportunity to produce power.

The greatly increased cost of multiple-effect evaporating units as used in large central stations is incurred to reduce the amount of steam that must be so degraded. In a university power and heating plant, such as Professor Christie describes, conditions are different. The demands for heating steam are so large that it is necessary to deliver high-pressure steam almost continuously to the reducing valves. It then becomes a matter of indifference whether this heat is degraded in the reducing valve or in the evaporator. Under such conditions a simple single-effect evaporator, throwing its vapor directly into the heating system, obviates any necessity for an evaporator condenser and makes an inexpensive and practical outfit that should soon pay for itself where the water is at all bad.

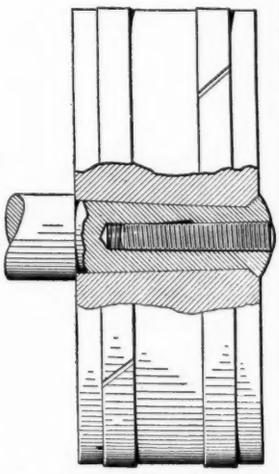
Practical Ideas from Practical Men



WITH a view to stimulating engineers into the habit of recording for the benefit of brother engineers, unusual occurrences, how these were met and other practical expedients adopted in the operation of their plants, Power has decided to award two cash prizes each month during 1925. One of $25 for the best and another of $15 for the second best practical letter on plant operation or practical kinks received during the month. This is in addition to payment for the contribution at space rates. The winners for February will be announced next month.

How the Piston Was Tightened on the Rod

Some years ago I was given the job of tightening a 22-in. piston on a 4-in. rod. The piston was shrunk on and the end of the rod riveted over as shown in the sketch. I had the piston and rod removed and taken to a machine shop, where a 1½-in. hole, about 8 in. deep, was drilled in the end of the rod. Into this hole a slightly tapered steel pin was driven, using a power-driven ram to do the driving. The pin expanded the rod and tightened it in the piston. The pin was then removed and the hole tapped as well as possible and a slightly tapered threaded bolt screwed into it, using a long wrench to do the turning. When the bolt was screwed in as far as it would go, it was cut off flush with the end of the rod and riveted over. The entire repair was made in a few hours and was a permanent job, as the piston is still tight on the rod after several years of service. JAMES E. NOBLE.



How piston was fastened on rod

Toronto, Ont., Canada.

Quick Repair Made by Grinding

In the operation of our plant it was necessary to start a large synchronous motor twice daily. It was brought up to speed by means of an auxiliary motor connected through a belt to a tight and loose pulley on the end of the synchronous-motor shaft.

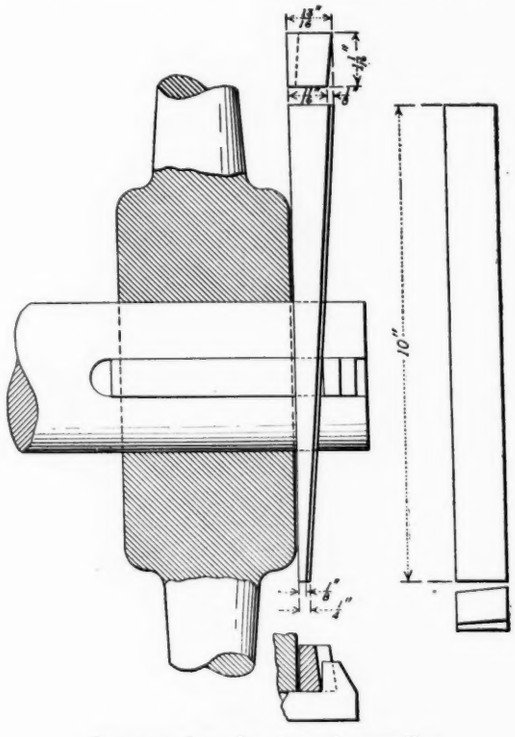
In time the journal of the loose pulley became worn and a repair was necessary. This necessitated turning down the end of the shaft and bushing the loose pulley to the new size. It was considered impractical to remove the rotor shaft for machining in a lathe as it was 7 in. in diameter and 20 ft. long.

An attempt was made to chip and file the shaft, but on account of extreme hardness and large amount of magnetism this plan was abandoned. Finally, we decided to do the job by grinding, so a portable electric grinder was obtained and mounted in position. As the loose pulley had been removed, some difficulty was had in getting the large motor started with the belt on the tight pulley, but once this was accomplished and the motor was running at normal speed, the grinding of the shaft was finished in a short time. W. J. LIGON.

Anderson, S. C.

Tool for Pulling Keys

The illustration shows a type of puller that has been in use in our shops for a number of years. The dimensions are given on the sketch, and one size of puller will take care of several sizes of keys.



Improved wedge type key puller

The tool is made from steel that can be tempered, and should be made hard enough to prevent it from rounding at the corners. The old type of wedge that is commonly used for this purpose has a tendency to rise away from the key.

The puller shown in the illustration is tapered two ways. When in use it is set with the wide part on top of the key, and the taper on the side tends to hold it down and make a straight pull on the key.

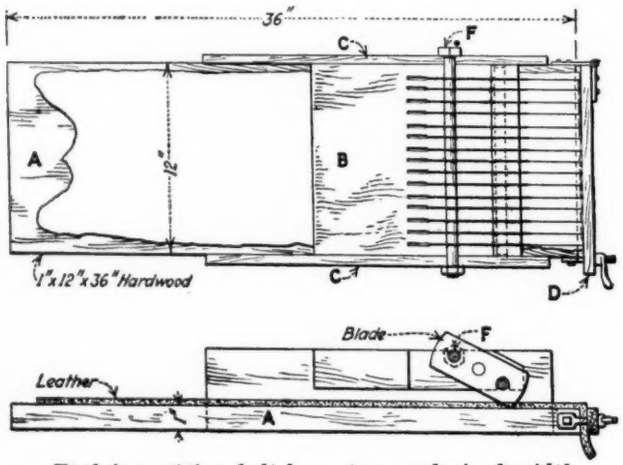
Norway, Mich. THOMAS PASCOE.

A Lace Leather Cutter

In the factory, shop or plant where many strings of lace leather are used each season, it is more economical to buy the tanned hides and cut the strings to suit than to buy the strings already cut in the different widths. But to cut the strings with a knife or shears, one at a time, is not satisfactory because of the uneven width of the laces and the time consumed. A cutter that will make as many as fifteen laces at a time can be made using safety razor blades for the knives.

Referring to the illustration, the base *A* is a 1x12-in. hardwood board 36 in. long. The cutting blade support *B* which is also of hardwood, is 12 in. wide and about the same length. One edge is divided off in spaces the width of the laces desired. At each division a slit is cut with a bracket or fret saw to a depth of about five inches. A groove is cut along the top and bottom surface of the board *B* to conform with the two outer holes of a razor blade as shown in the illustration. Guide boards *CC* are nailed or screwed to the blade carrier and slide along the edges of the base *A*. A rod slightly smaller than the hole in the blades passes through one hole of the blades and lies in the top groove of the carrier board. This bolt is used to clamp the blades in place. Another rod is placed through the other set of holes and rests in the bottom groove.

A strip *D*, hinged at one corner of the base *A* and held by means of a thumbscrew at the other end, holds the leather while the laces are being cut. The operation is simply to clamp the leather in place, then set



Tool for cutting belt laces to any desired width

the sliding part having the cutters attached over the baseboard and draw it along to the end.

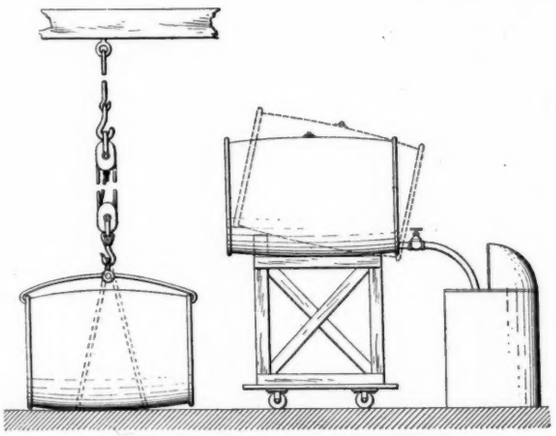
The blades may be set at various widths, or some of them may be left out when wider laces are wanted or when belting leather is to be cut into straps. Each of the four corners of the blades may be used as one becomes dull or breaks. In changing from one corner to another the blades are not removed from the rods; instead, the whole assembly is turned so that new cutting faces are used. G. G. MCVICKER.

North Bend, Neb.

Handling Oil in the Small Power Plant

Many plants waste more than enough oil in a year to pay for an equipment of first-class oil tanks. The regrettable part is that they pay for the equipment in waste and do not get the tanks.

The old round tin tank with a pump is better than a valve screwed into a barrel, but the real thing is the steel tank with welded seams with its non-drip measuring pump and its float and gage, giving a perpetual inventory of the stock.



How the barrels are handled

When the amount of oil used in a power plant justifies, a barrel dump is a good investment, but there are many plants too small to warrant the expense, and frequently in larger plants where oil must be stored in different sections of the plant, a quick way of dumping the barrels is a time and labor saver.

We have built a very convenient rack that can be set on a small four-wheeled truck. The barrel or steel drum, as the case may be, is rolled under the traveling crane and placed on end and the pipe valve and bend screwed into the head. The barrel is then tipped on its side again and either a sling slipped around it or the barrel hooks put over the ends to raise it onto the rack. The rack and barrel are then rolled to the oil tank. When the barrel is practically empty, a block is placed under the end away from the tank and the barrel is allowed to drain. In one department where there is no crane service, we have a $\frac{7}{8}$-in. rod suspended from the ceiling to take a pair of blocks on chain falls. In this way the barrels are easily handled.

Beloit, Wis. E. S. STEARNS.

Eliminating Noise in Check and Globe Valves

Frequently, high-lift check valves used on the suction and discharge lines of reciprocating pumps make considerable noise. A simple and inexpensive method of preventing this noise is to insert a bolt or setscrew through the cap of the valve and thereby limit the lift of the disk. This can be applied to either swing or straight lift checks. Care must be taken, of course, not to limit the lift of the disk sufficiently to affect the capacity of the pump. A locknut should be used to clamp the screw in place, once the lift has been set.

An equally simple method can be applied to angle or globe valves of either large or small diameter to

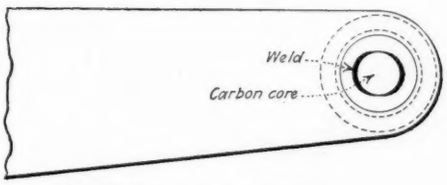
prevent the disk from vibrating when the valve is open. This is effected by simply placing over the valve stem a piece of brass pipe just long enough to clamp between the disk and the bonnet when the valve is open.

Toronto, Ont., Canada. JAMES THORN.

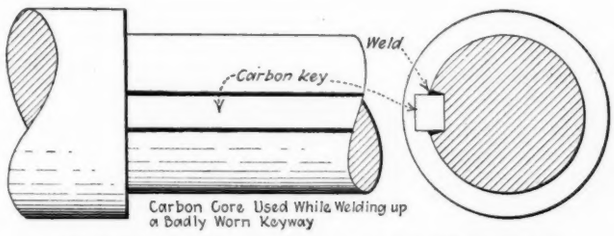
Use of Carbon Fillers While Welding Makes Machinery Unnecessary

To dispense with drilling worn or broken castings after welding, we use a piece of carbon to fill the hole while welding. This allows the welding metal to flow to the exact size required and saves considerable time and money in redrilling and fitting. The carbon fillers are made from the cores of old dry-cell batteries by grinding to the size required.

Before using this method we had a lot of trouble getting drills to stand up to the work of drilling reclaimed castings, but by using the carbon filler we did away



Method of Using Carbon Core While Welding up an Elongated or Badly Worn Bolt Hole



Method of using carbon cores or fillers when welding worn holes or keyways

with drilling entirely. In reclaiming brake equipment, this method cuts the cost 20 per cent and gives a longer life to the part reclaimed, as it leaves the hard skin on the metal similar to casehardening. In welding shafts with keyways or in fact any job that requires welding near holes or keyways, the machine work can be avoided by using carbon fillers. J. D. PRIDE.

Halifax, N. S., Canada.

Broken Valve on Air Compressor Causes Fire in Power Plant

It occurred to me that some readers of *Power* might be interested in an experience I had some time ago while chief engineer of a power station.

The supply of circulating water for the condensers was obtained from four deep-wells, and compressed air was used to discharge the water into a storage reservoir. The oiling system for the various engines was arranged with a supply tank, supported from the roof-trusses, air pressure being used to elevate the oil from the basement to this tank. The air for the several services was supplied by a 1,500-cu.ft. compressor which discharged directly to a 6-in. header below the engine-room floor, to which two smaller compressors as well as the supply pipes to the various wells were connected. In addition a 1½-in. line was run from the header to the oil-storage tank, for the purpose of elevating the oil into the supply tank on the roof trusses. The 6-in. header was laid on concrete piers, but it was not anchored except where the large compressor was connected.

One evening I had just reached home, which was about six minutes walk from the plant, when one of the oilers from the plant opened the door and shouted, "The basement is full of smoke; don't know where it comes from." Without anything further being said, we hurried back to the plant. In the meantime the watch engineer had stopped the compressor. By the time we arrived, the smoke was very thick, and appeared to be coming from the basement. Upon reaching the basement, we found the air-header curved up in the center and the pipe red-hot. I immediately grabbed a fire-reel, unwound the hose and turned the water on lightly until the pipe cooled enough to allow it to drop away from the wooden joists.

About this time I happened to see one of the oilers coming down the stairway to turn the air into the oil-storage tank. To prevent him doing so, causing an explosion, I turned the hose on him and later instructed him to discontinue the air for the purpose of elevating the oil, until the fire in the pipe had burned out. By that time the oil was getting low in the supply tank and we were anxious to get the air compressor in operation again and if possible keep it running until the peak load was over. However, we thought it best to let the fire in the pipe burn out before starting the compressor. Finally, the pipe seemed about straight and fairly cool, so the compressor was started. As soon as the air began to flow in the header, the temperature of the pipe began to rise, and upon opening a valve to the atmosphere, the flame rushed out like a blow-torch. We then turned on the reserve water supply to the condensers and began examining the compressor to locate the initial cause of the trouble. Upon removing the head from the air cylinder, we found one of the discharge valves broken, but as we had an extra valve in stock the compressor was soon ready for operation again.

The cause of the trouble was, of course, the broken discharge valve, allowing the air to leak back into the cylinder and be recompressed a number of times, until the temperature reached the ignition point of the oil used in the compressor cylinders. The reason the fire lasted so long in the header was because the pipe was coated with carbon about ¼ in. thick, which required a long time to burn out. F. C. BLOMBERG.

Little Rock, Ark.

In making welds with an electro-metallic electrode, the arc should be kept constant in length in order to insure uniformity in the metal deposited. This length will vary with conditions of the work, material being welded, apparatus used, etc., and can be determined best by experience. The electrode holder should always be connected to the negative terminal of the generator. If this is not done and the electrode is connected to the positive terminal, it will be more difficult to maintain the arc, which will tend to break and be extinguished frequently. Also the electrode will be consumed much more rapidly than is necessary and the metal deposited will not be as homogeneous as it should be.

Comments from Readers

Eliminate the Smoke

Recently, while riding across Long Island toward Brooklyn, I observed a smoke cloud drifting over the city and surrounding country and settling in the streets, as there was not sufficient wind to carry it away. Although the sun was still well above the horizon, the smoke was so dense at one point that people crossing the street a block away could be seen only very indistinctly. I then began to understand why it was that, after a house owner had brightened up his home with fresh paint, it so soon took on a dingy look, and I wondered how the money lost for, say, ten miles around the city could be computed.

About a year ago the Brooklyn Chamber of Commerce proposed to enforce the smoke ordinance, but so far no results seem to have been realized. Also, the American Society of Mechanical Engineers prepared a smoke ordinance that appeared to be up to date, but so far no results seem to have been reached, and I often wonder why the people submit to this needless nuisance without protest.

As an engineer, having had much experience with this problem for many years, I know that bituminous coal can be burned just as it comes from the mines, and under boilers, without objectionable smoke. The endeavor to overcome this nuisance several years ago led to the development of a device that any competent engineer in charge of a steam plant can readily construct, which aside from the elimination of smoke will net the boiler owner good returns on his small investment. So the question is, why do we submit to this nuisance? Is it because these facts are unknown, or is it a matter of indifference on the part of the boiler owners? Surely, it would seem that self interest, if nothing else, would justify the boiler owner's making some inquiry as to the truth of this statement.

Brooklyn, N. Y. W. H. ODELL.

Increased Height of Setting Usually Advantageous For Return-Tubular Boilers

Many engineers, when they read an account of a new power station and the results obtained, think, "If my boilers were only set like that, I, too, could get results." But why wish and wait. The majority of boilers have sufficient length of uptake to permit raising the boiler one foot, which is enough to improve combustion conditions greatly. If the boilers are in good condition and are likely to last from five to ten years longer, it would certainly pay to remodel them in this way. The boiler shell should be raised to at least 42 in. above the grate. The alteration to the steam piping is seldom an expensive matter, and by remodeling the brickwork thoroughly the setting will be as good as new. The greater length of blowoff pipe will require better protection than formerly. A good design of protecting baffle is to build a single tier of brick on three sides of the pipe, leaving an opening at the rear for inspection. I would not suggest raising the bridge wall, as that is usually high enough to permit raising the boiler a foot or more. The installation of a hand stoker will improve the combustion considerably even where the boiler has not been raised, as the stoker is set low at the rear, which increases the furnace volume, but of course, necessitates going below the floor about two feet for the ashpit. With these improvements properly carried out and the boiler kept clean inside and out, there is no reason why good results cannot be obtained. If the coal is high in volatile or fuel oil is to be used, the changes mentioned are absolutely necessary. If fuel oil is to be used, the setting must be lined throughout with a double or 9-in. course of firebrick laid with a good fireclay or cement. WILLIAM E. HOLT.

Fulton, N. Y.

What Causes the Black Spots?

The inquiry of G. E. Gardner in the Jan. 20 issue as to what caused the black spots recalls a similar experience I had about fifteen years ago with a 110-volt 400-kw. direct-current unit that operated in series with another unit of the same size and make These machines had given good service for several years, when one of them began to give trouble from black spots developing on the commutator, as described by Mr. Gardner.

Many different things were tried, including turning down the commutator and cutting the mica lower than the commutator bars. After the commutator had been turned up, the machine would work all right for a short time, but the old trouble would reappear. We had practically decided to order a new machine, when we discovered the cause of the trouble. One evening when the machine was being shut down, I happened to be standing close to the commutator, and just before the machine came to rest I heard something rattle in the armature. We removed the armature at once and after revolving it around on the floor a few times we found some iron slivers off the laminations lying loose on the inside of it. When the machine was in operation the centrifugal force had apparently held them in short-circuit across the commutator bars on the inside of the armature. When the machine was again placed in service, no further trouble developed.

Ponca City, Okla. V. K. STANLEY.

There are several causes for black spots to develop on a commutator, but by the fact that the spots are equally spaced and the same in number as the poles, it would appear that the brushes are too far advanced for light loads or not advanced far enough for the full load. This can be readily proved by rocking the brush yoke back and forth until the neutral point is found.

Some time ago spots developed on a machine of 850 kw. capacity from the cause just mentioned, and on

another occasion a machine that had run for several years without trouble developed spots similar to those described by Mr. Gardner. Investigation revealed that in making changes on the valve setting of the engine, a considerable change had been made in the speed. When the governor was adjusted to maintain proper speed, the sparking ceased and no more black spots appeared on the commutator. The brushes should be properly spaced and all set at the same angle on the commutator and with even tension on the springs.

Heating of the armature and commutator is often caused from collection of oil and dust stopping up the air passages. These should be examined regularly and kept clear.

When graphite brushes are used and sparking occurs from any cause, the brushes burn and wear away very rapidly, decreasing the tension of the springs. When springs become weakened, they should be replaced so that an even tension can be maintained on the brushes.

Cambridge, Mass. R. A. CULTRA.

The black spots as described by Mr. Gardner are undoubtedly caused from a grounded coil in the armature, and being an eight-pole machine, the spots would show up in eight places spaced equidistant around the commutator. Another likely cause is a poor connection where the coils are soldered to the commutator. It is very important that the connections at the commutator be properly made, otherwise they may heat and break down under full load conditions. We have had two cases recently, similar to the one described by Mr. Gardner. One was found to be due to grounded armature coil and the other to a poor connection to the commutator.

Woodward, Okla. HARRY J. ACHEE.

Use of Valves in the Water-Column Connections

I have read the argument of Franklin Cheney, in the Dec. 30, 1924, issue of *Power* about placing valves in the water-column connections to steam boilers. In my opinion this dangerous practice should be discontinued by all operating engineers.

I agree with the statement made by V. F. Hackleman in the Jan. 27 issue, that the water column is the most important part of a steam boiler. Engineers should see that these connections are examined at regular intervals, say, at regular cleaning periods, to make sure that scale and mud have not become lodged in them. Extra-heavy plugged tees or crosses, also extra-heavy pipe, should always be used in making the connections to the water column. J. D. PALMER.

Laramie, Wyo.

While the presence of a valve in the water-column connections may produce trouble through careless handling, its absence may cause considerable inconvenience also.

Recently, it was found that the water was sluggish in returning to the water column after blowing down and the usual method of closing the steam connection and blowing through the water connection would not free the obstruction. The weather was cold and we needed the boiler, but a dangerous condition could not be tolerated, so we had to let the steam down and clear the connection.

The column was connected to the boiler with the valves placed directly above and below the column, consequently the obstruction was between the valve and the boiler. Had the gate valve on the lower connection been placed between the boiler and the first plugged tee, a rod could have been pushed through and the obstruction removed, then the valve closed until the plug could be inserted, without any interruption to the service. Personally, I favor the use of valves on the water-column connections, but when they are used they should be placed as close to the boiler as practical so that the entire connection can be cleaned.

Toronto, Ont., Canada. R. MCLAREN.

What Is Wrong with the Boiler Setting?

With reference to Mr. Billings' inquiry in the Jan. 20 issue and the replies that have so far appeared on this subject, I wish to indorse the opinion expressed by Mr. Shields in the Feb. 17 issue.

Some time ago. I was employed as fireman in a plant where a new 72-in. by 18-ft. return-tubular boiler was installed with a setting similar to the one Mr. Billings describes. The furnace was fitted with an arch 7 ft. in length by 6 ft. wide running lengthwise with boiler. The draft was 4 in. and the fuel bed was carried 12 in. deep at front and from 3 to 4 in. at the rear. With these conditions it was impossible to get anywhere near the required rating out of the boiler, so we tried reducing the draft by closing the damper in the breeching half way and reducing the thickness of the fuel bed. Finally we cut down the length of the arch to 4 ft., 2 ft. on each side of the bridge wall. After these changes were made, the boiler steamed much better and ratings as high as 200 per cent were obtained.

In view of our experiences here, which proved that the arch, as installed, was much too large and the draft excessive, I would suggest to Mr. Billings that he experiment with different thicknesses of fuel bed and degrees of draft.

I hope he will let the readers of *Power* know what success he has or what changes were made in overcoming the trouble. J. R. BROWNLEE.

Toronto, Ont., Canada.

Some time ago we had about the same trouble with the hand type of stoker after it was first installed on a certain job.

We could not keep the steam up by operating the stoker as it was supposed to be operated, so the fireman stopped using the hand lever and he used his hoe to level the fires. He pushed the fire back so that he had as thick a fire in the back as he had in front, and then we had no trouble holding the steam.

After we had operated this way for a while, the stoker company sent a man to show us how to operate the stoker. The first thing he did was to operate the grates to work the fires ahead.

Everything went all right for a while until the thick fires we had in the back began to burn down, then the trouble started. The steam started to go down and it continued to go until he gave it up and turned the fire over to our own fireman, who immediately grabbed his hoe and pushed the fires back until he had almost as thick a fire at the rear as he did in front. When this was done, the pressure began to rise almost immediately.

Our furnaces were not fitted with the arch Mr. Billings mentions, and I fail to see why one is necessary.

West Haven, Conn. P. F. STUBBS.

Questions and Answers

Conducted by

Franklin Van Winkle

Thickness of Tube Sheets for H. R. T. Boilers

Why are the heads of horizontal return-tubular boilers made thicker than the shells? G. R.

The thickness must be appropriate for affording sufficient surface to receive expansion of the tubes and to resist tearing between tube holes or buckling from action of the tube expander. Hence, the minimum thicknesses of tube sheets for horizontal return-tubular boilers usually are $\frac{3}{8}$ in. for 42 in. diameter or under; $\frac{7}{16}$ in. for 42 to 54 in. diameter; $\frac{1}{2}$ in. for 54 to 72 in. diameter; and $\frac{9}{16}$ in. for tube sheets over 72 in. diameter.

Centrifugal Force as Square of Velocity

If the speed of a flywheel is doubled what effect would it have on the centrifugal force? L. R.

The formula for centrifugal force of a body revolving in a curved path of radius = R ft. is

$$F = \frac{Wv^2}{gR}$$

where F = centrifugal force in pounds, W = weight of body in pounds, v = linear velocity of the center of gravity of the body in feet per sec., and g = acceleration of gravity = 32.16.

Since the centrifugal force varies as the square of the velocity, it follows that if the speed is doubled the centrifugal force would become four times as much.

Stiffness of Springs on Pump Valves

What is the rule for the proper pressure to be exerted by the springs of pump valves? We are supplied with these springs in long coils which are to be cut to proper length and cannot tell whether the springs have the correct stiffness. M. M.

An approximate rule is (1) make the spring pressure in pounds per square inch on the discharge valve area equal to $\frac{1}{2}$ to 1 per cent of the discharge pressure, but not in excess of 5 lb. per sq.in. on that area. (2) Make the spring pressure on the suction valve area equal to $\frac{1}{4}$ to $\frac{1}{2}$ lb. per sq.in. if the water is lifted by suction. If the water comes in under a head, make the spring pressure on the suction valve area equal to $\frac{1}{2}$ to 1 lb. per square inch.

Discharge of Boiler Test Pump

In making a hydrostatic pressure test of a boiler that is first completely filled with water, and there is no leakage, what becomes of the water discharged at each stroke of the test pump required to obtain the test pressure? G. M.

Pure water is so slightly compressible that the contraction of volume for an increase of pressure would not be perceptible in operation of an ordinary boiler test pump. Any air contained in the boiler would be compressed to smaller volume, and as the pressure is increased a perceptible quantity of water can be added, because the cubical content of the boiler becomes increased by change of dimensions from relative movement of parts before stresses are taken up by stays and bearings on rivets, and from changes of form from the elasticity of the materials. When subjected to pressure, heads and flat surfaces tend to assume true spherical form and a cylindrical shell tends to assume a true circular form.

Testing Leakage of Pump Valves

If a pump has a tight water piston, what would determine whether there is leakage of the discharge or the suction valves? F. L.

During the suction stroke there should be no leakage of the discharge valves, and during the discharge stroke there should be no leakage of the suction valves. To test the tightness of the valves, open the water-cylinder pet-cocks. Then to test the tightness of the discharge valves, close the suction stop valve and with a finger placed lightly over each pet-cock opening, run the pump slowly and note whether there is good suction at the pet-cock of the end making a suction stroke. To test the tightness of the suction valves, open the suction stop valve and with the discharge stop valve closed, note whether the cylinder pressure shown at the pet-cock on the discharging end will hold higher than the suction-pipe pressure during slow discharge strokes.

Source and Prevention of Clinker

What causes formation of clinker and how can it be prevented in hand firing? M. G.

Clinker is formed by fusion of substances contained in the coal or which may have become mixed with the fuel. The slag comes from such impurities in coal as iron, sand, clay, lime, sulphur and magnesia. When heated together, the sand, lime, etc., form a pasty fluid mass like melted glass, varied in color, according to the impurities present, and this slag flows over the ash and other fuel ingredients that are not melted, and when cooled the solids are cemented together, forming the rough mass called clinker.

To make a slag, an acid substance must be heated with a basic substance. Sand, lime, clay, etc., when heated separately, will withstand higher temperatures than exist in boiler furnaces, but when heated together will melt easily. However, when either the sand or the base is greatly in excess, a much higher temperature is required for fusion. Hence, formation of clinker can be hindered by adding limestone, magnesia rock or oyster shells to the fire.

Clinker trouble may be caused by a thick fuel bed shutting off the air supply so the ash near the grates may become heated and fused together. Another cause of clinker trouble is stirring the fire, thus bringing the ash to a hotter part of the fuel bed, where it becomes

fused and produces clinker. Hence, to aid in overcoming clinker, have thin fires and keep the fire bed even by placing fresh fuel on the thin spots. The fire should not be leveled with a rake or mixed with a slice bar. Ash on the grates should be kept as cool as possible so it will not be cemented together into a clinker, and the ashpit should be kept clean and cool as possible.

A jet of steam or water kept in the ashpit will help greatly to prevent fusion of the ash on the grate and there will also be an advantage from keeping the ashpit doors open, depending as far as practicable on adjustment of the stack damper for regulation of the draft.

Throttle Valves for Two-Cylinder Corliss Engine

Should a two-cylinder Corliss engine having a 14x42-in. and a 16x42-in. cylinder, connected to one shaft as a pair, be equipped with a separate throttle valve for each cylinder? *J. J.*

In addition to a main stop valve for controlling the steam supply to both cylinders, separate throttles are not absolutely necessary, but should generally be supplied for saving of time and greater convenience in changing over to or from operation of only one side when the connecting rod and valve gear of the other side are temporarily disconnected, as when one side of the engine is not required by the load, or when one side may be laid off for adjustments or repairs. Separate throttles also admit of easier control for starting or for bringing the engine to a given position when stopping or if backing is required, for operation of the valves of one side of the engine by hand while the throttle of the other side is closed.

Safe Pressure for Dished Heads

What is the formula for the safe working pressure for an unstayed convex or concave head of a steam drum? *L. C.*

The required thickness of an unstayed dished head with the pressure on the concave side, and when it is a segment of a sphere, is given by the formula:

$$t = \frac{5.5 \times P \times L}{2 \times TS} + \frac{1}{8} \qquad (1)$$

where

t = thickness of plate, in.;
P = Maximum allowable working pressure, lb. per sq.in.;
TS = Tensile strength of material, lb. per sq.in.;
L = Radius to which the head is dished, in.

Where two radii are used, the longer is to be taken as the value of L and in no case is L to be taken as less than 80 per cent of the diameter of the head.

By transposing (1), the maximum allowable working pressure on the concave side is found to be,

$$P = \frac{(t - \frac{1}{8}) \times 2\ TS}{5.5 \times L} \qquad (2)$$

When there is a manhole opening, the formula is to be

$$P = \frac{(t - \frac{1}{4}) \times 2\ TS}{5.5 \times L} \qquad (3)$$

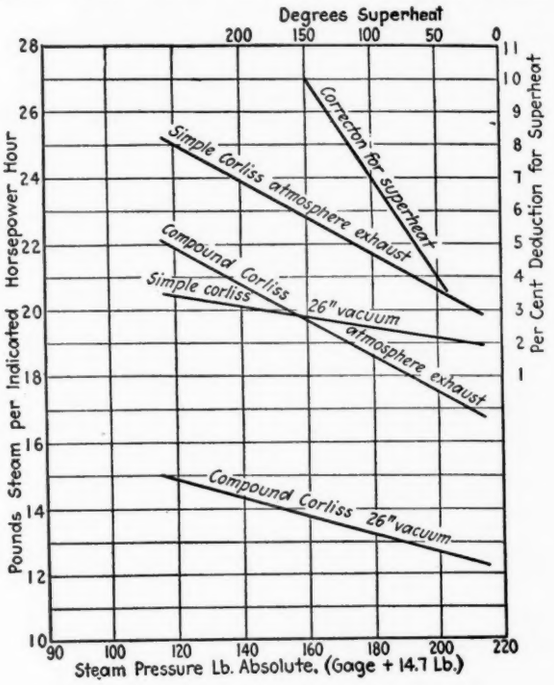
and the manhole opening is to be flanged to a depth measured from the outside of not less than three times the thickness of the head. It is also to be understood that the formulas shall apply only to cases where the corner radius, measured on the concave side of the head, is not less than 1½ in. or more than 4 in., and within these limits not less than 3 per cent of the value used for L in the formulas given.

When the pressure is on the convex side, the maximum allowable working pressure is 60 per cent of that for dished heads of the same dimensions with the pressure on the concave side.

Relative Economy of Simple and Compound Corliss Engines

What is the relative economy of simple and compound Corliss engines when operating non-condensing and condensing? *A. E. F.*

The economies will vary with the initial and back pressure size, design, speed, load and percentage of leakage of valves and pistons. When operated at the most economical loads and at the usual speeds, Corliss engines of good design and under good working conditions should develop the relative economies shown by the chart. For instance, for operation with dry saturated steam at the initial pressure of 180 lb. absolute given at the foot of the chart (or 180 — 14.7 = 165.3 gage pressure) the simple Corliss engine with atmospheric exhaust should have an economy of about 21¾ lb. of steam per indicated horsepower-hour as given at the left of the chart; the simple Corliss with 26-in. vacuum, about 19¾ lb.; the compound Corliss with atmospheric exhaust, about 18¾ lb.; and for the compound Corliss with 26-in. vacuum, about 13¼ pounds of steam per indicated horsepower-hour. When the initial steam is superheated, the curve labeled "correction for superheat" near the upper right-hand corner of the chart shows approximately the deduction to be made from the given steam consumption in any case when there is 50 to 150 deg. of superheating of the initial steam. For instance, for 100 deg. superheat given at the top of the chart, there would be a deduction of 7 per cent, shown at the right of the chart; or in the same way, it is shown that for 50 deg. superheat the deduction would be 4 per cent.



Relative economies of Corliss engines under good conditions

A new slant on things observed in and out of the power plant

What Happens and Why?

A Pound of Water

THE fact that steam normally occupies a much greater volume than liquid water is familiar to all engineers, as is the fact that this volume increases rapidly as the pressure is reduced. But, while the relative volumes of steam and water at ordinary boiler pressures are fairly easy to picture, a study of the complete range from extremely high to extremely low pressures will yield a few surprises to those who have not considered the matter.

If a pound of water (about two cupfuls) is poured into a container 1 ft. square, it will rise to a height of about 0.016 ft., or 1/62 ft. This is merely another way of saying that a cubic foot of liquid water weighs about 62 lb. or that a pound of water occupies 0.016 cu.ft. It is assumed that the temperature is around normal room temperature. This one pound "slab" of water 1 ft. square and 0.016 ft. thick is pictured at *A*.

It will be interesting to follow this pound of water through the various changes illustrated by the square sections shown at *B*, *C*, *D*, etc. Subjecting it to an absolute pressure of 3,200 lb. per sq.in., the temperature is raised to 706 deg., the critical temperature. The volume of the water will be about tripled, as shown at *B*, which applies to both water and steam at this temperature and pressure where water and steam are momentarily the same thing.

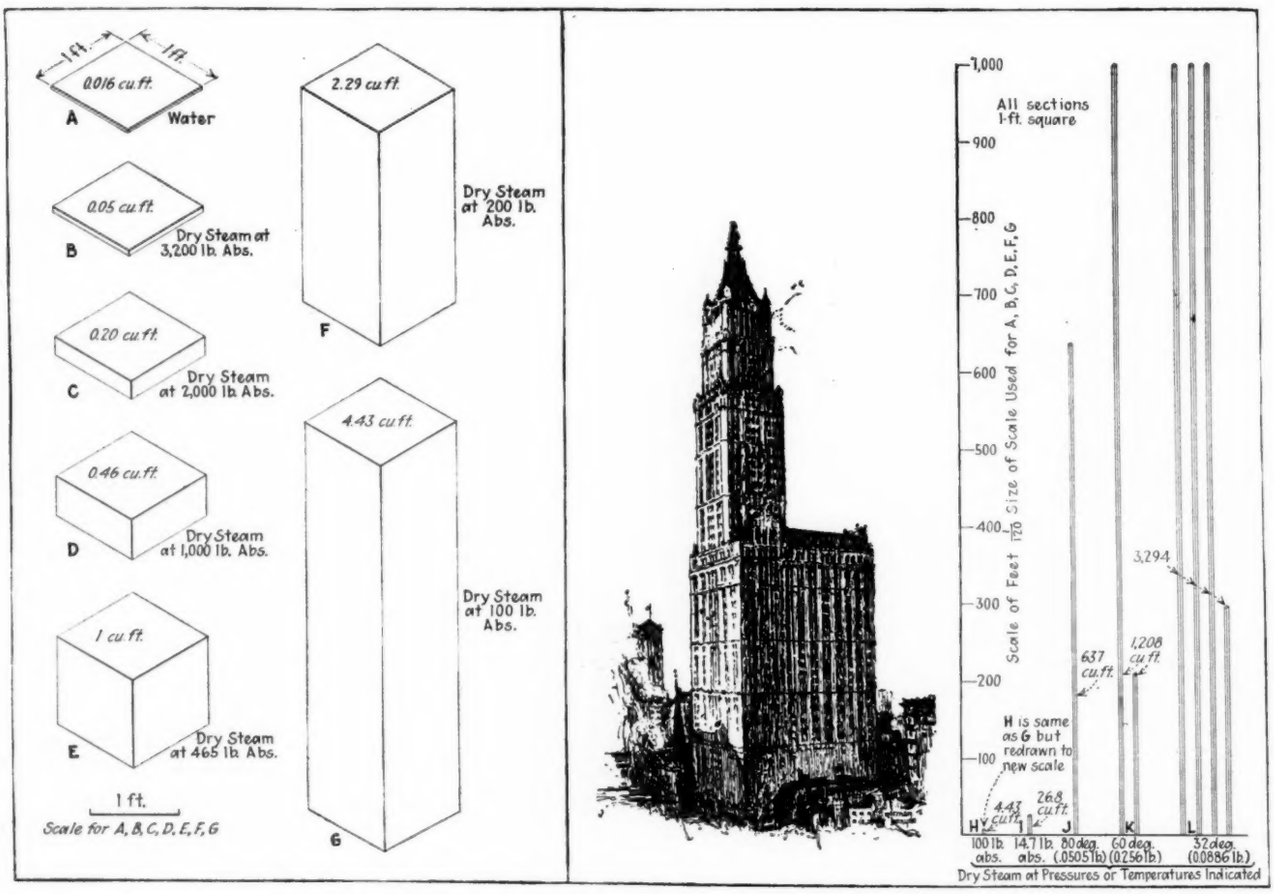
Then, keeping the one pound in the form of dry saturated steam, the pressure is gradually reduced. At 2,000-lb. absolute pressure the volume has increased to 0.20 cu.ft. (*C*), at 1,000 lb. (*D*) to 0.46 cu.ft. and at 465 lb. to exactly one cubic foot. The last is an interesting figure to remember.

The effect of further reduction to 200 lb. and 100 lb. is shown at *F* and *G*. The expansion from *A* to *G* seems large (in fact it is about 276 times), yet this expansion pales into insignificance in comparison with what is possible under easily attainable conditions. Turn to the right half of the figure, where *G* is redrawn at *H* to a much smaller scale.

The 792-ft.-high Woolworth Building and the 1,000-ft. scale serve as means of comparison. At atmospheric pressure (*I*) the volume is up to 26.8 cu.ft. At 80 deg., a common exhaust temperature for condensing turbines, the single pound of dry steam would fill a box one foot square and 637 ft. high.

To get still smaller vapor pressures within the field of daily experience, it is necessary to imagine the atmosphere soaked with moisture; that is, a 100 per cent "humid" day. If, on such a day, the temperature is 60 deg., one pound of moisture will fill 1,208 cu.ft., while at 32 deg. 3,294 cu.ft. would be occupied. The presence of the air does not affect the volume occupied by a given weight of dry steam or vapor at a given temperature.

To drive home the amount of this expansion, picture a cubical can, 1-ft. square, full of water. As saturated vapor at 32 deg. this water would fill a solid row of such cans 40 miles long.



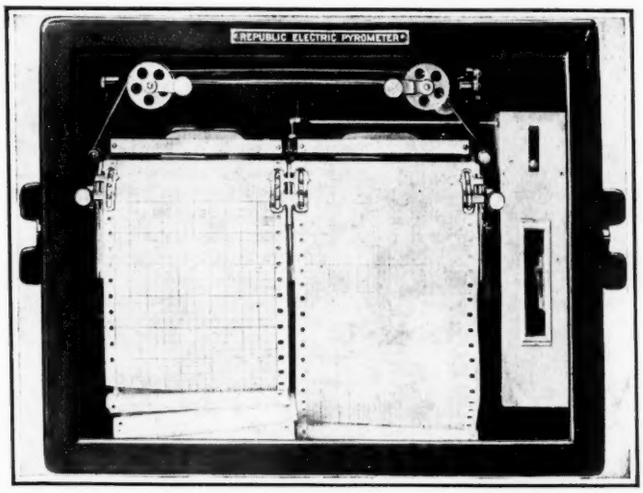
Tracing one pound of water through an expansion of 205,000 times

New and Improved Equipment

Republic Electric Recording Pyrometer

In addition to the wall-type indicating pyrometer shown in Fig. 6, page 944, Dec. 9, 1924, issue, the Republic Flow Meters Co., Chicago, Ill., has added several pyrometric instruments together with complete accessory equipment, the most important of these instruments being the recording pyrometer illustrated herewith.

Two independent charts are used on the instrument instead of printing two scales on one chart. This makes it possible to have practically any combination of scale ranges desired. The charts are 6 in. wide which permits an open scale, the chart 32 to 3,000 deg. F. having 20 deg. to each division. A complete list of chart ranges is provided to meet practically any requirements. A tear groove is provided directly at the driving drum to permit extraction of the record without waste of chart. In operation a carbon ribbon is automatically moved across the face of the chart and the instrument pointer moves between a depressor bar and the back of the ribbon. The pointer deflects in proportion to the temperature of the hot junction of the thermocouple. A knife-edge is placed beneath the chart at the point where the depressor strikes. The depressor drops once a minute and makes a carbon dot on the face of the chart. The carbon ribbon does not oscillate for ward and backward and only its edge overlaps the knife-edge, with the result that as soon as the depressor rises it is possible to see beneath the carbon ribbon and note the last dot that has been made.



Two independent charts permit combination of scale ranges

Toggle switches are placed on all instruments to short-circuit the coil when the instrument is in transit.

Illmer Oil-Engine Injection Pump

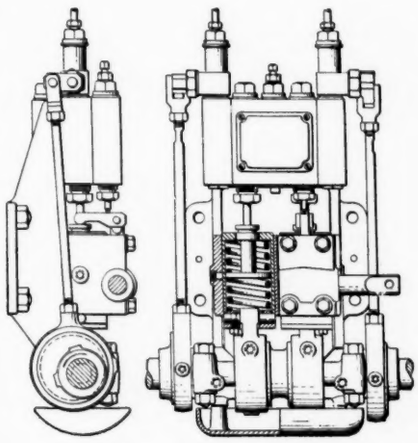
An impulsion-type pump to be used for direct injection on high compression of engines has been designed by Louis Illmer, Philadelphia, Pa. This new pump is distinguished from such fuel pumps as have heretofore been offered, in that it is provided with an elastic plunger drive, which, in recovering, imparts a decided "kick," or impulsion stroke, to the plunger at the time of fuel injection. By the use of this system it is possible, without the use of compressed-air injection, to maintain an exceptionally high discharge velocity at the nozzle, and to effect atomization of the liquid fuel regardless of the speed at which the engine is operated.

The delivery of this pump is controlled by simple bypass means to regulate the amount of fuel injected into the power cylinder and meet the changing requirements of the engine load. In addition, the fuel pump is equipped with means for producing a sharp cut-off at the spray nozzle for effectively preventing any dribble at the end of the injection period.

The drive comprises a tubular casing that slides in the guide bore of the pump bracket housing. The driven plunger is floatably mounted with respect to the casing by means of a powerful intermediary spring. The actuating casing surrounding this plunger drive is given reciprocating movement from a rotating eccentric.

The pump chamber is provided with a suction check valve and a mechanically operated discharge valve. The latter valve opens against the chamber pressure at a fixed point of the eccentric travel. The positive opening of this discharge control accurately times the delivery from the pump and therefore constitutes an important element in the pump structure. This timed discharge valve is piped to a spray nozzle of an open check-valve type, which injects directly into the engine cylinder.

During each downward stroke of the plunger oil is sucked into the pump



Illmer oil-injection pump

chamber in excess of the amount required by the engine cylinder. Upon completion of the suction stroke, the actuating gear reverses the plunger movement and lifts the casing of the impulsion drive. This in turn promptly closes the automatic suction valve, and thereafter all valves of the pump remain closed until such time as the discharge valve is mechanically opened.

Prior to this opening of the discharge valve no oil is allowed to discharge from the pump chamber; this causes the spring-driven plunger part to be held in a virtually stationary position while the impulsion-drive spring is being compressed by the continued upward movement of the actuating casing.

Impulsion energy is thereby gradually stored in the intermediary drive springs without mechanical knocks or other detrimental hammer-blow effects of any kind, and a high, predetermined pressure is at the same time set up throughout the pump chamber passages in the manner of a hydraulic accumulator. The extent to which the drive spring is allowed to compress during the first portion of each and every discharge stroke of the plunger-actuating gear is determined by the fixed timing given to the discharge valve opening.

The release of the impulsion energy that has been stored behind the plunger is held under the direct control of the positively operated discharge valve. The subsequent opening of this valve instantly allows the compressed drive spring to impel the plunger rapidly forward and imparts a kick, or impulsion stroke, to the plunger at the very

time the pump is injecting fuel into the engine cylinder. Unaided, the slow-moving actuating gear could not accomplish this desired action.

De Laval Reduction Gears

The accompanying illustrations show a type of reduction gear recently brought out by the De Laval Co., Trenton, N. J. The gear is made in two general types. In one type the driving worm is below the worm wheel as shown in the sectional view, Fig. 2, and in the other the worm is above the wormwheel, thus making the gear adaptable to a variety of drives.

The worm is made from a low-carbon alloy steel forging which is heat treated after the threads are cut and finally ground all over. The worm-wheels are made from a special composition of phosphor bronze. For large sizes the rims only are made of bronze and are shrunk on cast-iron

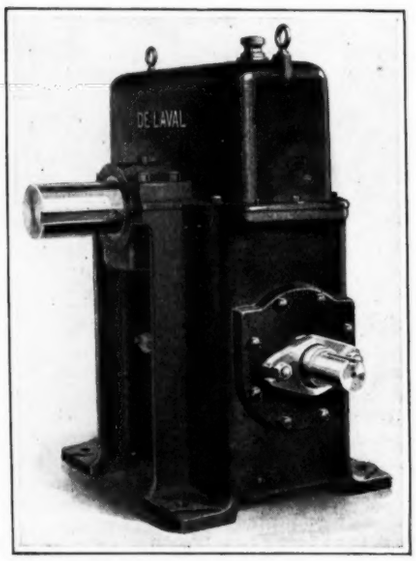


Fig. 1—Worm-gear reduction unit with bottom drive worm

centers and secured in place by threaded keys riveted in place. To insure accuracy of the pitch line of the teeth, the gear wheel is mounted on its own shaft and hobbed on its own bearings.

In both types the casing is split horizontally in the plane of the center line of the wheel shaft, the lower part of the casing forming an oil reservoir. The wheel shaft is carried on plain bronze bearings so split that they are readily removable without disturbing the shaft or coupling. The side thrust of the wheel is carried by hardened steel plates placed between the wheel hub and the bronze face of the wheel shaft bearings. The worm shaft is mounted on ball bearings, the one at the rear of the worm being of the double type designed to carry the combined radial and thrust load. The front bearing is of the radial type and is mounted to permit lineal expansion of the shaft. The bearings are carried in separate housings, the arrangement being clearly shown in Fig. 2. The worm and wheel as well as the bearings are lubricated by the splash system, the oil thrown from the gear being caught in troughs cast on the casing wall and thereby led to the bearings.

The gears are made for transmis-

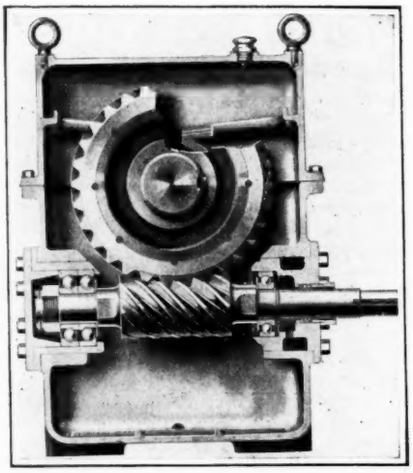
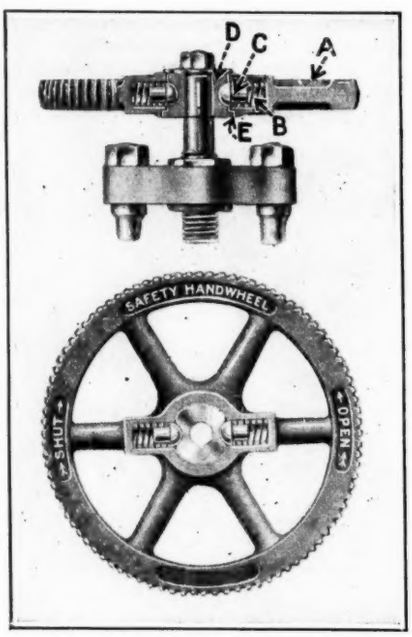


Fig. 2—Section of speed-reduction unit

sion ratios of approximately 4 to 1 up to 100 to 1 in one step and for higher ratios with double reduction.

Safety Handwheel for Valves

With a view to providing a means of preventing damage to valves through the application of excessive force, the



Section of safety handwheel

safety handwheel shown in the illustration has been brought out by the Victory Valves, Ltd., Adswood, Stockport, England.

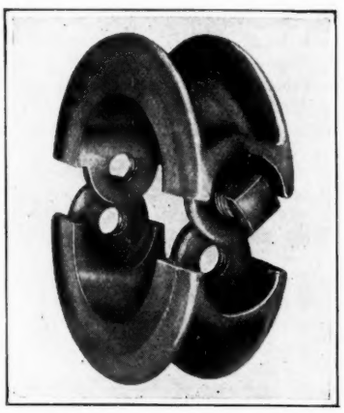
The principle of the device will be clearly understood by referring to the illustration. The part *D* which forms the central portion of the hub, is machined to fit on the valve spindle in place of the regular handwheel. The outer surface of the hub carries two recesses into which the clutch members *C* are held under tension of the springs *B*. A brass liner *E* is fitted between the body of the handwheel *A* and the hub *D* to obviate any tendency for corrosive action.

When opening or closing valves to which this handwheel has been fitted, if excessive force is applied to the handwheel by means of levers or other methods, the extra force overcomes the strength of the springs *B* and the clutch members *C* release their grip on the friction disk *D* and the handwheel then rotates independently. The springs *B* are, however, of such a strength that they do not compress and allow the handwheel to slip until the load is abnormal.

Link-Belt Split Type Safety Collar

The Link-Belt Co., Indianapolis, Ind., has recently added to its line of safety collars and is now marketing the split-type shown in the illustration.

The collar is designed for use in



Split type safety collar

maintaining alignment of such equipment as pulleys, shaft bearings and hangers, and is readily installed on shafting already in place as the collar is split in two pieces. The setscrew by which it is affixed to the shaft is flange protected. The material of which the collar is made is said to be rust-resisting and was selected with a view to extending the application of the collar to installations where the atmospheric conditions contribute to rust or abrasiveness.

Porto Rico Plans Hydro Development—A development on Rio Blanco in the municipality of Naguaba in Porto Rico is proposed in a preliminary permit sought by Arsine L. Arpin. It is proposed to divert four tributaries to a point near their junction with the Rio Blanco. One power house is to be located at that point. A second power house is planned for the foot of the cascades. A total head of 1,900 ft. is obtainable and 5,600 hp. will be installed. The development is within the Luquillo national forest.

Comparison of Medium-Speed and High-Speed Hydraulic Turbines*

Plant Efficiencies Compared for High- and Medium-Speed Installations Containing Two, Four, Six and Eight Units—Comparisons Are Also Made of Efficiencies for High- and Medium-Speed Units Under Varying Heads

By GEORGE A. JESSOP
Hydraulic Engineer, S. Morgan Smith Company

DATA given in this article are obtained from tests made in the Holyoke flume and in the specially designed and constructed flume of the company with which the writer is connected. The efficiencies are based on model runners of the size usually tested at the Holyoke flume — about 39 cu.ft.-sec. discharge under one-foot head. It is possible to obtain better results with larger wheels under good conditions. In the following, comparative efficiencies which can be obtained by using medium-speed wheels, specific speed, N_s, equals about 75, and high-speed wheels, N_s, equals about 175, are indicated:

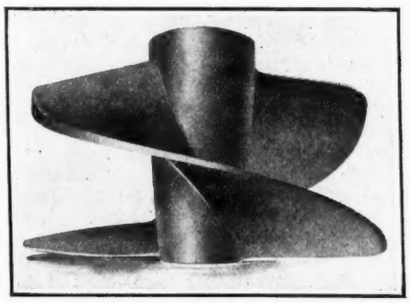
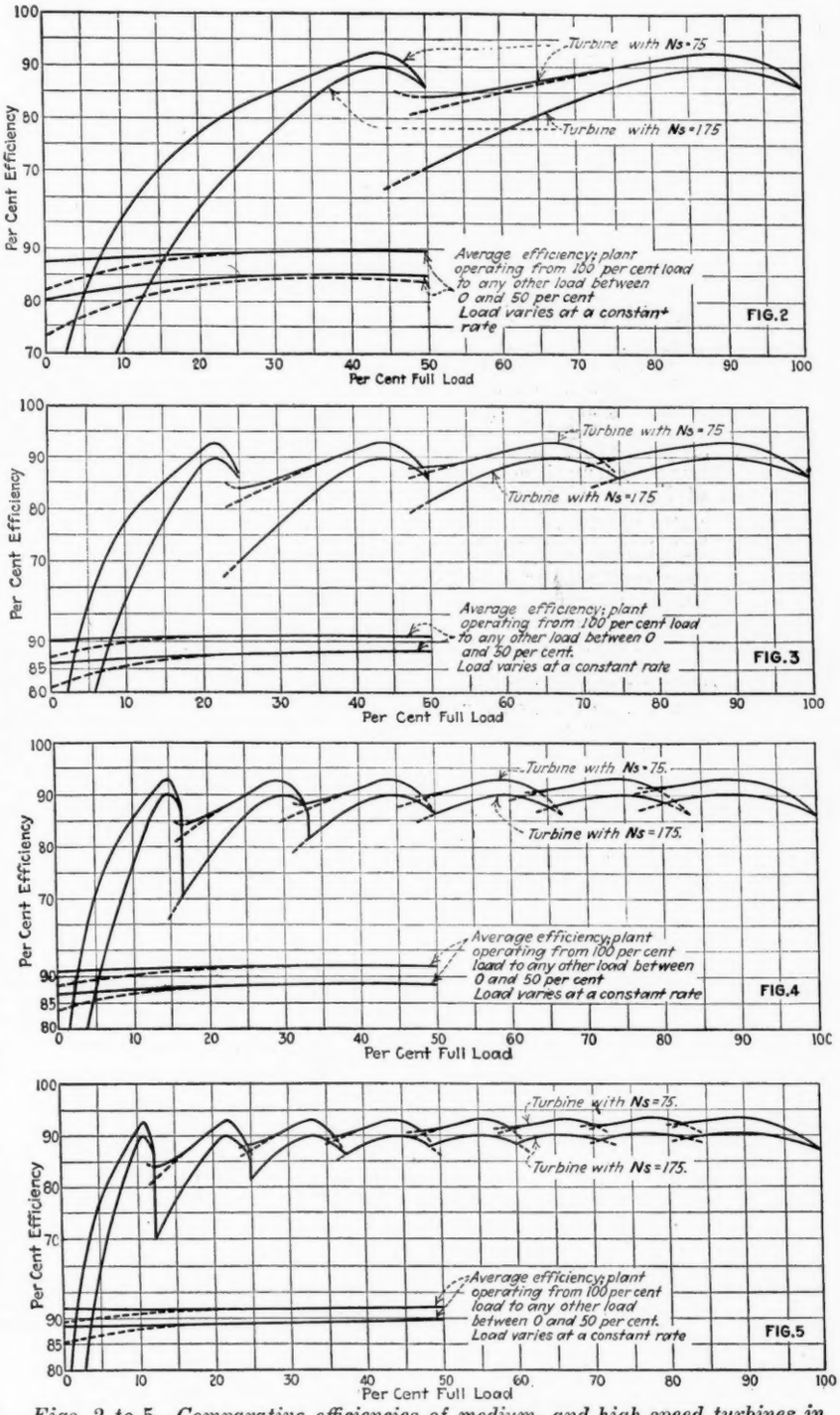


Fig. 1—Two-blade Bell runner; designs for three- and four-blade runners being developed

The medium-speed runner is of the Francis type and of the normal design. The high-speed runner, Fig. 1, is a design first developed and used by The Theodore Bell Co., Switzerland, and now being further developed and improved jointly by the engineering staff of The Bell and S. Morgan Smith Co. The latter company controls the patents for this country and for Canada. It is distinctive in that it has fewer blades than is usual on high-speed wheels, and the total blade area is exceptionally large. The hub is also especially large.

An inspection of the curves will show that this wheel has its peak efficiency at about 90 per cent load, comparing favorably with the slower-speed runner in this respect. This is a desirable feature, because the turbine can be operated at its most economical point with a liberal allowance of power for regulating purposes, and furthermore, this design assists in obtaining high part-load efficiency.

*Paper presented before the Power Section of the Annual Convention of the American Society of Civil Engineers, New York City. Jan. 21 to 23, 1925.


Per Cent Efficiency
Per Cent Full Load
Turbine with Ns=75
Turbine with Ns=175
Average efficiency; plant operating from 100 per cent load to any other load between 0 and 50 per cent. Load varies at a constant rate
FIG.2
FIG.3
FIG.4
FIG.5

Figs. 2 to 5—Comparative efficiencies of medium- and high-speed turbines in two-, four-, six- and eight-unit plants

For low heads—that is, heads of 30 to 40 ft. and under—the comparison given here is possibly somewhat less favorable to the high-speed wheel than it should be, because usually for these heads, if a Francis runner is used, it will be of a specific speed of about 100 to 120 and will have a slightly lower peak efficiency and considerably lower efficiency at half to three-quarter load, than a wheel with N_s equal to about 75.

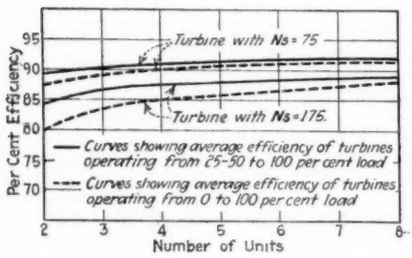

Turbine with Ns=75
Turbine with Ns=175
Curves showing average efficiency of turbines operating from 25-50 to 100 per cent load
Curves showing average efficiency of turbines operating from 0 to 100 per cent load
Per Cent Efficiency
Number of Units

Fig. 6—Shows how the average efficiency increases with the number of units in the plant

Furthermore, this being a comparison of turbines only, the increased efficiency of the high-speed generator is not taken into account. A comparison of the results that can be obtained with plants containing from 2 to 8 units of the medium- and high-speed types, together with some averages, is given in Figs. 2 to 5.

Fig. 2 shows the comparison between medium- and high-speed wheels in a 2-unit plant. Up to 50 per cent station load only one unit is in operation. Above 50 per cent load the curve is the resultant or combined efficiency of the two units. For the medium-speed wheels, when operating between 50 and 75 per cent load, higher efficiency can be obtained by running one wheel at maximum efficiency and supplying the rest of the power demand by running the second unit at the required gate opening than by dividing the load equally between the two units. The efficiency to be gained by the unequal distribution of load is shown by the full and dotted lines. The high-speed wheels show maximum efficiency when the load is equally divided. In order to determine whether it is economical to divide the load equally or unequally between two or more units, it is necessary to figure each plant separately, using the curves that apply. To the left, on the same figure for convenience, curves have been plotted, showing the average weighted efficiency, with the station operating from 100 per cent load to any other load between 0 and 50 per cent, based on the load varying at a constant rate.

The weighted efficiency for a given range of load is simply the total horsepower-hours output divided by the total water horsepower-hours input, the latter being actually computed from the discharge curves, which are not shown in these figures. In computing the average weighted efficiency for any given range of output, it is necessary to use a definite load curve, and for purposes of comparison only a load curve that varies from the minimum to the maximum output at a constant rate has been used.

For example, if the load varies from 40 to 100 per cent, the average weighted efficiency is about 89.5 per cent for the 75 N_s wheel and about 84.5 per cent for the 175 N_s wheel. If the load varies from 0 to 100 per cent, the average weighted efficiency is about 87 per cent for the 75 N_s wheel and about 80 per cent for the 175 N_s wheel.

The dotted curves are simply the arithmetical averages of the efficiency and are plotted to show that, at least for approximate preliminary purposes, where the load varies from about 25 to 100 per cent, it is sufficiently accurate, perhaps, to use the more easily determined arithmetical average rather than the weighted average. The possible exception to this statement is in the case of the high-speed turbine for the 2-unit plant, where the difference between the numerical and weighted efficiency is material. For the curves under discussion the numerical efficiency is always less than the weighted efficiency, but for the range where the curves are shown coincident, the differences are too small to be shown with the scale used.

Fig. 3 shows the same comparison, as made of Fig. 2, for a 4-unit plant, Fig. 4, a 6-unit plant and Fig. 5 an 8-unit plant. With a 6- or an 8-unit plant containing medium-speed wheels and an output equal to 50 per cent or more of the maximum capacity, there is very little advantage in dividing the load other than equally between the units.

Fig. 6 shows how the average efficiency increases with the number of units. The full lines are plotted using the averages for ranges of load, starting with full load and decreasing at a constant rate to any percentage between 25 and 50—the efficiency being practically constant for any range between these limits. The dotted lines are plotted using the averages for a range of load from full output to zero. The average efficiency for any number of units, with the range of load varying from full load to any point between 25 per cent and zero, can easily be approximated.

It is not intended that these curves be used to determine the average efficiency of any station using medium- or high-speed wheels, it being necessary to compute the averages for each individual case. The curves simply indicate how the wheels compare in general, and it must be considered that if the station is operated a greater length of time at nearly full capacity than at the low capacities, the average efficiencies will be increased over the values shown, and the averages of the high-speed wheels will increase more rapidly than those of the medium-speed.

The comparative average efficiencies as shown in this article may, perhaps, be considered somewhat unfavorable to the high-speed wheel. To bring the average efficiency of the high-speed wheel to a point more nearly to that of the medium-speed wheel, it is necessary to increase the efficiency of the former. By using high-speed wheels of a specific speed somewhat less than that selected, it is not only possible to obtain a substantial increase in the peak efficiency, but the part-load efficiencies are increased even more.

No attempt has been made to show a comparison of the average efficiencies under variable head conditions. Fig. 7 shows that the high-speed wheel has a better range at variable speed or variable head than the medium-speed turbine. The power and efficiency of the high-speed wheel holds up particularly well under low-head condition. It follows, therefore, that where the percentage of head variation is considerable, the comparison between the two wheels will be somewhat more favorable to the high-speed type.

For example, in Fig. 7, the normal head on the two wheels is 20 ft. Under this condition both wheels have about the same efficiency at 100 per cent normal load and reach their maximum efficiency around 90 per cent load, which is about 92.5 per cent for the medium-speed and about 90 per cent for the high-speed wheel. Under a 16-ft. head the high-speed wheel develops about 72 per cent of its rated power, against 71 per cent for the medium-speed wheel, with an efficiency of about 91 and 89 per cent respectively at about 90 per cent maximum load. If the head is reduced to 12 ft., the medium-speed wheel will develop only about 42 per cent of its rated power and its best efficiency is about 80 per cent, where the high-speed wheel is good for 50 per cent of rated power at an efficiency of about 87 per cent. It is obvious that under these conditions the high-speed wheel is superior to the medium-speed type. At an increase in head above normal, for example, at 24 ft., it will be seen that there is a tendency for the curves of the two wheels to approach each other.

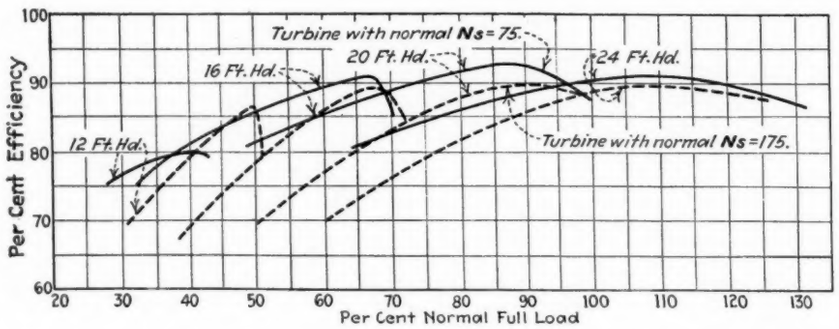


Fig. 7—Comparison of medium- and high-speed turbines under varying heads, normal head 20 feet

Refractory Classification and Characteristics

By H. W. Brooks

INCREASING interest has been manifested in refractories in the combustion field with the recent rapid development of pulverized fuel. The need of developing a means of burning larger quantities of coal per cubic foot of combustion space is increasingly apparent. There are available many refractories of various kinds in addition to the usual flint fireclay firsts and seconds best known to the boiler furnace trade. A classification including all the present better known refractories follows:

Clay:
- (a) Flint fireclay.
- (b) Kaolin.
- (c) Siliceous fireclay.
- (d) Plastic fireclays.
- (e) High aluminous clays.

Silica:
- (a) Lime bonded.
- (b) Clay bonded.
- (c) Fused.
- (d) Silica—ferric oxide combination (example "Bull Dog").

Alumina:
- (a) Corundum.
- (b) Bauxite.
- (c) Diaspore.
- (d) Gibbsite.
- (e) Alumina clay (40-52 per cent Al_2O_3).

Magnesia:
- (a) Magnesite.
  - (1) Commercial.
  - (2) Electrically fused.
  - (3) Magnesite—bonded.

Chromium:
- (a) Chromite.

Dolomite:
- (a) Crude.
- (b) Calcined.
- (c) Fluxed.

Lime:

Spinel:
- (a) Natural.
- (b) Artificial.

Sillimanite:
- (a) Electrically fused (recrystallized).
- (b) Bonded.

Carbon:
- (a) Clay bonded.
- (b) Graphite:

Zirconia:
- (a) Oxide.
- (b) Silicate.

Silicon Carbide:
- (a) Bonded.
- (b) Recrystallized.
- (c) Silicon oxy-carbide (example "Fibrox").

Porcelain Type:
- (a) Talc and talc bodies.
- (b) Alumina-silica-magnesia bodies.

Nitrides and Borides:
- (a) Aluminum nitride.
- (b) Boron nitride.
- (c) Silicon boride.

Cerium, Beryllium, Thorium Oxides:

Insulating Refractories:
- (a) Kieselguhr (natural bond).
- (b) Kieselguhr (clay bond).
- (c) Kieselguhr cork-clay combination.
- (d) Asbestos.
- (e) Magnesia.
- (f) Magnesia-asbestos combinations.
- (g) Magnesia lime combination (example "85 per cent Magnesia").

Many furnace operators are inclined to judge a refractory by only two or three, at most, of its many qualities. Depending upon the application there are 22 elements or more that must be considered in a proper application of refractories. To serve as a guide to a study of refractory problems, the following classification of characteristics with descriptive notations will be of interest:

Principal Considerations Governing Correct Refractory Application

1. Chemical Composition.
   Impurities of 1 or 2 per cent near softening point may cause failures. Presence or absence of free silica determines basic or acid reaction and resistance to fused ash as clinker or fused particles in gases.
2. Physical Composition, Flux, Bond, etc.
3. Mineralogical Composition, Structure and Texture.
   Conversion of quartz to cristobalite. Crystallization of sillimanite. Formation of tridymite. Crystallization of spinels, recrystallization of periclase in magnesite, formation of accessory minerals, etc.
4. Refractoriness, Fusion Points—in Cones or Temperatures.
   Tendencies of fused refractory to drip and disturb slag composition. Salvageability. Rapid firing results in higher fusion temperatures than slower.
5. Permanent Expansion or Contraction upon Reheating.
6. Expansion or Shrinkage (in use).
   Durability under repeated heats. Stability of walls and arches. Clay, magnesite and alumina contract; siliceous materials expand.
7. Porosity.
   Absorption by capillary action.
8. Permeability.
   Resistance to penetration of liquids and vapors, fused coal ash, oil spray, slags, glass, carbon, metallic vapors, reduced metals, hydrocarbons, superheated steam, SO_2, SO_3, Cl_2, etc.
9. Hardness and Density.
   Resistance to destruction by fireman's tools.
10. Specific Gravity.
11. Specific Heat (Heat Capacity).
12. Thermal Conductivity or Insulating Value.
    In muffles, retorts, etc., conductance through walls to charge important.
13. Resistance to Sudden Temperature Changes.
    Spalling, shattering, etc.
14. Resistance to Slagging Action.
15. Resistance to Chemical Agencies (Acid, Neutral, Basic).
    Fluxing or dissolving action.
16. Mechanical Strength.
    Compression, tension, shearing, etc.
17. Resistance to Compression at Furnace Temperatures.
18. Resistance to Abrasion.
19. Electrical Resistance and Dielectric Strength.
20. Miscellaneous Physical Properties.
    Friability, lamination, cracking, slaking, blisters, blowholes, cores, etc.
21. Size and Shape Tolerances (Brick as Shipped).
    Thin joints give greater strength and insulating value and lower costs of setting.
22. Price F.O.B. Manufacturer's Plant.

Power Equipment as Real Estate Fixtures

By A. L. H. Street

An interesting court decision, showing the legal status of boilers, smokestacks, etc., installed under a conditional sale contract on premises covered by a mortgage held by a third person, was lately handed down by the United States Circuit Court of Appeals, Fifth Circuit, in bankruptcy proceedings affecting Moultrie Creamery & Produce Co. (2 Federal Reporter, 2d Series, 129).

A creamery plant was successively operated by a partnership, an individual and a corporation. After the plant had been mortgaged and the corporation had been organized, the company bought two boilers, a smokestack, etc., under a contract reserving title in the seller until full payment therefor. After the corporation was adjudged bankrupt, controversy arose between the holder of the real estate mortgages and the seller of the equipment mentioned concerning right of the latter to reclaim the equipment, which had been installed in the usual way by being cased in with brick, etc. Disposing of the controversy, the court said:

"If the contention was entirely between the parties to the contract, it would be governed by the intention of the parties as expressed in the reservation of title; but, being between a prior mortgagee with an after-acquired property clause as to the improvements, the question is: Is the property a removable fixture under the common law? . . . The mortgages were on a creamery plant; it was in operation with machinery in it as a creamery plant when the mortgages were created. For this machinery the property in question was substituted. It could not be removed without destroying the property as a creamery plant, although it will leave the building practically unhurt for future use in conjunction with that or similar machinery as a creamery plant. The machinery could not be used, except in conjunction with that or some similar building. It was therefore at law a [real estate] fixture.

During January there were 57 mechanical stokers sold, which were installed under 4 fire-tube boilers of 8,700 sq.ft. heating surface and 53 water-tube boilers of 270,010 sq.ft. heating surface, according to figures published by the Department of Commerce.

World Production of Coal In 1924

From the incomplete information that is available, it is estimated that the world's total production of all coal in 1924 was approximately 1,350,000,000 metric tons. In comparison with the output in 1923 this was a decrease of about 9,000,000 tons. The chief factor contributing to the decline was the decrease of more than 14 per cent in the output of soft coal in the United States, and to less important decreases in Canada, Great Britain, Poland, Hungary, Russia and Japan. All the other countries for which figures are shown in the table reported increased production. Following the settlement of the economic disorders that attended the occupation of the Ruhr, production increased rapidly and the total coal, 118,829,000 tons, was within 10 per cent of the 1922 output. The production of lignite also increased and totaled 124,360,000 tons.

The following table, prepared by W. I. Whiteside, of the Section of Foreign Mineral Reserves, summarizes the information received by the Geological Survey up to March 14. Estimates have been used for less than 5 per cent of the world's output.

COAL PRODUCED IN THE PRINCIPAL COUNTRIES OF THE WORLD IN THE CALENDAR YEAR 1924

(In metric tons of 2,204.622 lb.)

Country	1924
North America:	
Canada: Coal	11,900,000
Lignite	.....
United States: Anth.	82,000,000
Bit. and Lignite	438,420,000
Other countries	(a)
South America	(a)
Europe:	
Belgium	23,360,000
Czechoslovakia: Coal	34,866,000
Lignite	.....
France: Coal	44,955,000
Lignite	.....
Germany: Coal (b)	118,829,000
Lignite	124,360,000
Saar	14,032,000
Hungary	7,200,000
Netherlands: Coal	5,882,000
Lignite	190,000
Poland	(c) 32,000,000
Russia	(c) 14,000,000
Spain: Coal	(a)
Lignite	.....
United Kingdom: G. Brit.	273,453,000
Ireland	(a)
Other countries	(a)
Asia:	
China	(a)
India, Brizish	20,524,000
Japan: Coal	(c) 30,000,000
Lignite	.....
Other countries	(a)
Africa:	
Union of S. Africa	11,331,000
Other countries	(a)
Oceania:	
Australia:	
New S. Wales	11,805,000
Other states	(a)
Other countries	(a)
Total	1,350,000,000

(a) Estimate included in total. (b) Of which the Ruhr produced 90,240,000 tons. (c) Estimates from monthly figures as follows: Poland and Russia, 11 months; Japan, 9 months.

Alps Can Furnish Water Power to France

Prof. Henri Chaumat, in a paper read before the Grenoble International Exhibition of Water Power, is reported by the press as saying that from 600,000,000 kw.-hr. to 700,000,000 kw.-hr. is the estimated water power that the Alps can supply to France. He pointed out that this would mean a great saving to France, as that country buys foreign coal to the value of 3,000,000,000 francs annually.

Industry Recognizing Power Advantages of West

Industry is responding very definitely to the attraction exerted by the power resources of the West. This was the observation of Maj. Glen E. Edgerton, the assistant chief engineer of the Federal Power Commission, who just has returned from an extended trip through the Pacific Coast states. While there is some immediate advantage in the matter of power cost for the industries that go West, the present differences in rates alone are not all that is influencing the plans of so many concerns. It is the assurance that present rates, or even lower rates, will prevail in the West for a long time in the future, as development goes forward. There is abundant evidence, he states, that this advantage is being weighed very carefully by many power users in other sections of the country.

120,000 Kw. Power Ready At Wilson Dam July 1

Installation of the four main units of the power generating machinery at the Wilson dam practically has been completed. Gen. Harry Taylor, the chief of engineers, reported March 16, on returning to Washington from an inspection visit at Muscle Shoals. While the switchboard is not ready, it will have been completed by July 1 and 120,000 kw. of power will be available at the end of the dam on that date.

No steps have been taken to provide transformers, as Congress has made no provision for the possibility of disposing of any portion of the power at a distance.

In the closing hours of the special session of Congress, March 18, Senator Norris made a speech on "The Water Power Trust," Senator McKellar of Tennessee declared that if the Underwood bill disposing of the Muscle Shoals power project had been passed, the people of Tennessee would not have been benefited in the slightest, while Senator Norris's bill to dispose of the project would have been of great benefit to them.

Water Power Resources of Canada, Feb. 1, 1925

With the installation during 1924 of new waterwheels of over 200,000 hp. there is now installed a total of 3,569,275 hp. in the Dominion of Canada, and by the completion of plants under construction this figure will be increased by 600,000 hp. before the end of 1925. These figures are contained in the Report of the Dominion Water Power & Reclamation Service of Canada, dated Feb. 1, 1925.

The known available water power in Canada is 18,255,000 hp. for conditions of ordinary minimum flow and 32,076,000 hp. for maximum development or for six months of the year. Figures indicate that this will permit of a turbine installation of 41,700,000 hp., whereas only 3,567,275 hp., or 8½ per cent, is at present installed.

The 3,569,275 hp. is used as follows: 2,696,997 hp. in central stations; 503,039 in pulp and paper mills with additional 228,755 hp. purchased from central stations; 369,239 hp. in other industries. The total installation averages 386 hp. per thousand population it is estimated.

The rapid development of the electric drive in the paper mills is indicated by the fact that 215,472 hp. installed is connected to generators which, added to the 228,755 hp. purchased, gives a total electric drive of 444,227 hp., or over 60 per cent of the power used.

The total installed horsepower has grown from 975,000 to 3,569,275 since 1910; central station from 605,000 to 2,696,997 hp. and pulp and paper mill from 191,000 to 503,039 hp. The investment represented by the installation of 3,569,275 hp. is estimated at $767,000,000.

AVAILABLE AND DEVELOPED WATER POWER IN CANADA

	Available 24-Hr. at 80 Per Cent Efficiency		
Province	At Ord. Min. Flow Hp.	At Ord. 6-Mo. Flow Hp.	Turbine Installation, Hp.
British Columbia..	1,931,142	5,103,460	355,722
Alberta	475,281	1,137,505	34,107
Saskatchewan	513,481	1,087,755	35
Manitoba	3,270,491	5,769,444	162,025
Ontario	4,950,300	6,808,190	1,585,182
Quebec	6,915,244	11,640,052	1,308,106
New Brunswick	50,406	120,807	44,656
Nova Scotia	20,751	128,264	63,957
Prince Edward Is..	3,000	5,270	2,276
Yukon & Northwest Territories	125,220	275,250	13,209
Total Canada	16,255,316	32,075,998	3,569,275

The daily average gross crude oil production in the United States for the week ended March 7 was 1,944,450 bbl., as compared with 1,943,750 bbl. for the preceding week, an increase of 700 bbl., the American Petroleum Institute estimates.

Appropriation for Study of St. Lawrence River

The chief engineer of Army Engineers announced on Mar. 18, that an allotment of $275,000 from current appropriations has been made to be used for surveys and preparations of plans of the St. Lawrence River. The allotment is to cover the cost of the resurvey of the St. Lawrence deeper waterway project as a preliminary to embarking on a definite program in conjunction with the Canadian government.

Canada Approves of Power Project on St. John River

The Canadian government has approved the application of the New Brunswick Hydro-Electric Commission for authority to construct a power project on the St. John River on the international boundary, including the construction of a dam above Grand Falls. The approval of the International Waterways Commission and presumably of the State of Maine and the United States Federal Power Commission will be necessary before construction can be started.

Los Angeles Building New Dam in San Francisquito

A simple gravity arch concrete dam is being built by the Los Angeles Water and Power Bureau between power plants No. 1 and No. 2 of the Los Angeles aqueduct in San Francisquito Canyon. This dam, scheduled for completion early next year, will develop a storage capacity of 38,000 acre-ft. which can be used in years of heavy run-off to save water that would otherwise be wasted. Water collected in this reservoir can be turned back into the aqueduct at San Francisquito No. 2 power house.

The structure will have a total height of 205 ft. over all and will contain 140,000 cu.yd. of concrete. It will resemble in many respects the Weid Canyon dam, completed by this department last year in the hills above Hollywood.

Efficient Use of Coal Saves Railroads $44,000,000

Greater efficiency in the use of fuel by the railroads in 1924 resulted in a saving of $29,500,000 compared to 1923, according to estimates made by the *Railway Age*. The estimates do not allow for savings made, due to reductions in the price of coal.

The average number of pounds of coal consumed per 1,000 gross ton miles of road freight service in 1923 was 161 lb. and in 1924 only 149 lb., a reduction of 12 lb. and the best year's record ever made. Total gross ton miles in 1924 were 1,085,765 millions. The amount of coal saved in road service by increased efficiency in its use was, therefore, 6,514,590 tons. The average cost in 1924 was $3.05 per ton and, therefore, the saving was about $19,870,000. The amount of coal consumed in passenger service was reduced from 18.1 to 17 lb. per passenger-train car miles, or 1.1 lb. This made a further saving of almost 2,000,000 tons.

Oil Burner Manufacturers' Tentative Program

The tentative program of the second annual meeting of the American Association of Oil Burner Manufacturers, which is to be held at Edgewater Beach Hotel, Chicago, April 1-3, has just been given out. Papers of interest to *Power* readers are as follows:

"Oil Burning in Canada," by Lionel L. Jacobs, Foss Oil Burners of Canada.

"Some Reflections on Basic Engineering Experience in Oil Burning," by Ernest H. Peabody, Peabody Engineering Corp.

"Analysis of Oil Flames," by James L. Breese, Jr., Breese Engineering Corp.

"Installation Standards," by E. J. Smith, Underwriters Laboratories.

"Facts About Galvanized Tanks, and Their Installation," by Edgar A. Bienenstok, Milwaukee Tanks Works.

"Facts About Black Tanks and Their Installation," by A. A. Butter, Graver Corp.

"Proper Venting of Oil Tanks," by R. J. Anschicks, Protectoseal Co.

Engineer Board Did Not Pass on Chicago Diversion Rights

On Mar. 6 the Milwaukee Engineers' Society held a special meeting at the request of T. Chalkley Hatton, chief engineer of the Sewerage Commission of the City of Milwaukee, who was a member of the board of 28 engineers who reported on the question of "Sewerage Disposal and Water Diversion through the Chicago Drainage Canal." It was brought out by Herman L. Ekern, attorney-general of Wisconsin, that the question of justice, legality and right of water diversion at Chicago was not considered by the Engineering Board of Review, but that the Board assumed that 10,000 cu.ft.-sec. were to be diverted and merely investigated means by which the trouble caused by the diversion might be corrected. The work of the Board was divided among committees, each one of which dealt with one phase of the subject only and took the findings of the other committees for granted.

Report on Oils for January Made by A. P. I.

The production, imports, stocks, exports and domestic consumption of refined gas and fuel oil and lubricating oils have been estimated by the American Petroleum Institute as follows:

	Barrels of 42 Gallons	
	Gas and Fuel Oil	Lubricating Oil
	Jan., 1925	Jan., 1925
Production	27,890,525	2,456,292
Daily average	899,694	79,235
Imports	1,053,484	1,385
Daily average	33,984	45
Stocks:		
End of month	38,564,003	6,392,130
Increase during month	*d* 1,210,019	265,077
Daily average	*d* 39,033	8,551
Exports	2,454,570	946,555
Daily average	79,180	30,534
Indicated domestic consumption	27,699,458	1,246,045
Daily average	893,531	40,195

d Denotes decrease.

Patent Office Transferred to Hoover Control

Jurisdiction over the Patent Office, heretofore a part of the Interior Department, was transferred to the Commerce Department, under Secretary Hoover on March 18, by an executive order of President Coolidge. The change, recommended by the Congressional Committee to consider general government reorganization, was possible without specific legislative action because the law which created the Commerce Department gave the President discretionary authority to place such regular bureaus as he might select under its control. Other alterations which the Commission recommended are not expected until Congress has acted.

Consumption of Fuel Oil by Locomotives

A total of 63,206,034 bbl. of fuel oil was consumed by locomotives of the principal railroads in the United States in 1924, compared with 58,005,295 bbl. in 1923, according to returns received from railroads by the American Petroleum Institute. These figures include fuel oil consumed in all classes of service. The total consumption of 63,206,034 bbl. in 1924 was made up of 51,251,563 bbl. of domestic fuel oil and 11,954,471 bbl. of Mexican fuel oil. In 1923 of the total consumption of 58,005,295 bbl., 46,407,231 bbl. were domestic oil and 11,598,064 bbl. Mexican fuel oil.

The largest consumption of fuel oil was shown in the Middlewestern and Southwestern district, totaling 32,651,547 bbl. in 1924 divided into 22,274,891 bbl. of domestic fuel oil and 10,376,656 bbl. of Mexican fuel oil. This compares with 27,448,445 bbl. in 1923, of which 17,126,042 bbl. were domestic fuel oil and 10,322,403 bbl. Mexican fuel oil.

A. S. M. E. Council Meeting Held at Charlotte

The A.S.M.E. Council held a joint meeting with the Carolinas' Section at Hotel Charlotte, Charlotte, N. C., on March 16 and 17. The Carolinas' Section was organized and is composed of branches of the A.S.M.E. at Greenville, S. C., Raleigh, N. C., and Charlotte, N. C. David J. Kerr, Canton, N. C., was elected chairman with Prof. L. L. Vaughan, of Raleigh, N. C., and James B. Mayo, Greenville, S. C., as other members of the committee.

A banquet was given to the Council and visitors in the ballroom of the Hotel Charlotte on the evening of March 16, at which Dr. W. F. Durand and others made addresses. During the business session, which was held during the following day, it was decided to hold the Council meeting in connection with the Regional meeting at the Penn Alto Hotel, Altoona, Pa., Oct. 5-7. An invitation was received to hold the spring meeting, 1926, at San Francisco.

Inspection trips to hydro-electric and steam plants of the Southern Power Co. at Mountain Island and Mt. Holley were taken by members and visitors as well as a visit to the new Ford plant at Charlotte.

Delaware River Compact Signed by Gov. Smith

The Tri-State Compact regarding the conservation of resources of the Delaware River as described in *Power*, Dec. 23, 1924, page 1040, and Feb. 3, 1925, page 200, was signed by Governor Smith of New York, on March 18. Pennsylvania has already signed the compact, and it now remains for the New Jersey Legislature to act before this development can begin. The last report was to the effect that the Senate decided to postpone action for another year to permit of further study by a commission of experts.

Standard Gas Electric Co. To Spend $22,949,000

According to an announcement by H. W. Fuller, vice-president in charge of engineering and construction of the Byllesby Engineering & Management Corp., the public utilities of the Standard Gas & Electric Co. will spend $22,949,000 for construction this year. Among other improvements to transmission lines, substations, etc., some work will be done on the High Bridge power station; a 6,700-hp. turbo-generator will be installed in the La Crosse plant of the Wisconsin-Minnesota division; a 33,500-hp. turbo-generator with auxiliary equipment will be placed in the Waterside plant of the Louisville Gas & Electric Co.

Water-Power Projects

Kentucky River Developments—The Federal Power Commission has issued a preliminary permit for the Kentucky Hydroelectric Co., of Louisville, covering proposed developments at Locks No. 1 to 8 inclusive on the Kentucky River.

Grape Creek Project.—The Federal Power Commission has issued a preliminary permit for the Southern Colorado Co. covering a development on Grape Creek, a tributary of the Arkansas River. Two reservoirs are to be created, which will permit of the development of 13,500 horsepower.

New River Project — The Eastern States Development Co. has applied to the Federal Power Commission for a preliminary permit covering a project on New River and Fisher River at the boundary line between Virginia and North Carolina. It is proposed to construct a dam in New River just below the mouth of Meadow Creek, near Oldtown in Virginia. A reservoir will be created which will extend twenty miles up stream and will completely regulate New River. A tunnel from Meadow Creek will connect with the power house on the headwaters of Fisher River, which is a tributary of the Adkin. Four dams are to be constructed in Fisher River, creating continuous reservoirs above the lower dam, which will be put in three miles north of Crutchfield, N. C. There will be a power house at each dam. No estimate of the power to be developed was submitted.

Foss River Project—Fred B. Allard applied to the Federal Power Commission for a preliminary permit covering an installation on Foss River in King County, Washington. The site is one hundred miles above Seattle. The power is intended for public utility use, but no estimate of the amount to be developed was submitted.

Clearwater River, Ore., Plan — The California-Oregon Power Co. has applied for a preliminary permit covering a project on Clearwater River fifty miles east of Roseburg in Douglas County, Oregon. The dam will create a storage reservoir six miles long. No estimates have been made as yet as to the amount of power that can be developed.

Cauley and Meadow Rivers Project.—Preliminary permits have been issued by the Federal Power Commission for the Cauley Power Co. of Charlestown, W. Va., covering a proposed project in Cauley and Meadow Rivers. The development involves six dams in the Cauley and four in the Meadow River. In addition storage dams in the tributaries of Cauley River are contemplated. It is proposed to install 55,000 horsepower.

Society Affairs

The Lehigh Valley Section of the A.S.M.E. will have as the subject for its April 3d meeting "Storage and Handling of Coal."

The Vancouver Section, Wash., of the A. I. E. E. will hear a paper by R. H. Hall, on "Power Factor Correction," at its April 3 meeting.

The Milwaukee Section of the A.S.M.E. will have as the subject for its April 15 meeting "Co-operation Between the State University and Industry."

The New Haven Section of the A.S.M.E. will hold its April 7 meeting at the Mason Laboratory. C. K. Baldwin, V. P. Robins Conveying Belt Co., will speak on "Development of Belt Conveyors.

The Petroleum Division of the American Chemical Society will hold sessions during the spring meeting, which is to be held in Baltimore April 6-10. J. E. Babb will have a paper on "Lubricating Greases."

The Akron Section of the A.S.M.E. will hold its March 31 meeting at the Engineering Building of the University of Akron. The subject will be "Instruments for Measuring," with E. B. Bailey, president of the Bailey Meter Co., Cleveland, as speaker.

The Pacific Coast Electrical Association Technical Section will hold a meeting in Fresno, Calif., March 25-27. Meetings will be devoted to hydraulic power, underground systems, meters, accidents, prime movers and other subjects of a like nature.

The Ontario Section of the A.S.M.E. will have as the subject for its April 8 meeting, which will be held at the University of Toronto, "Present Tendencies of Steam Generation." J. O. Twinberro, of Babcock-Wilcox and Goldie-McCulloch, Ltd., Galt, Ont., will be the speaker.

The Colorado Section of the A.S.M.E. will make an excursion to the La Comb power plant on March 27.

The American Society of Civil Engineers will hold its 55th annual convention at Cincinnati April 22-24. Papers will be given at the Power Session by L. F. Harza, consulting engineer, Chicago, on "The Dix River Dam of the Kentucky Hydro-Electric Co.," and by S. D. Heed, general manager of the Union Gas & Electric Co., on "Steam Power Plant at Mouth of Big Maimi River."

The Chicago Section of the A.S.M.E. held a special machine-tool meeting, on March 11 with afternoon and evening sessions. For the first attempt of any magnitude in this field the meeting was a decided success. An excellent program had been provided, and although the attendance was not up to expectations (about 100 at the evening session and one-half this number during the afternoon), the interest shown and the general appreciation made it evident that another meeting of this character in next year's program would receive more support.

The Metropolitan Student Branches of the A.S.M.E. will hold a joint meeting with the Metropolitan Section, as is the usual custom, on March 31, at the Engineering Societies Bldg., 29 West 39th St. After an afternoon trip to some point of interest dinner will be served at the Engineering Building, after which the technical session will be held. William N. Angus, of Columbia University, has been elected chairman and Charles Beyer, College of Engineering, Newark Technical School, secretary in charge of the meeting. "Mechanical Phases of Newspaper Work," by Herbert Gunnison, of the *Brooklyn Eagle* and "Unit System of Burning Pulverized Coal," the speaker to be announced later, and an address by Dr. W. F. Durand, president of the A.S.M.E., will be included in the afternoon and evening programs.

Business Notes

The Standard Turbine Corp., Scio, N. Y., announces the appointment of Howell Ross Hanson as district representative at 2200 Packard Bldg., Philadelphia, Pa.

The Warren Steam Pump Co., Warren, Mass., announces that the Vincent-Gilson Engineering Co., Inc., 30 Church St., New York City, has been appointed as New York district representative for the company.

The Swartwout Co., Cleveland, Ohio, announces that George H. Thomson, for the last twelve years manager of its New York office, has been appointed general sales manager with headquarters at Cleveland.

The Cyrus Wm. Rice & Co., water chemists and engineers, Pittsburgh, Pa., are announcing a new monthly newspaper, *Control*, to appear about April 10. This house organ will be devoted to discussions and technical articles on feed-water treatment control.

The Carborundum Co., manufacturer of firebrick materials, Niagara Falls, N. Y., announces that Farrand P. Hall has been appointed district sales manager at Cleveland. Mr. Hall succeeds

John MacArthur, who has been assigned to special sales work, with headquarters at Niagara Falls.

The Bernitz Furnace Appliance Co. has removed its main office from 177 State St., Boston, Mass., to larger quarters in the new Chamber of Commerce Bldg., 80 Federal St.

The Northern Equipment Co., Erie, Pa., manufacturer of the Copes system of boiler feed control, announces the appointment of W. G. Woodside, O'Reilly St., No. 11, Havanna, as sales representative for Cuba.

The Homestead Valve Manufacturing Co., Homestead, Pa., announces appointments of distributors as follows: W. A. Case & Sons, 72 St. Paul St., Rochester, N. Y.; The Fulton Supply Co., Atlanta, Ga.; Charles A. Setzer, Mfrs. Agent, 725 Realty Bldg., Charlotte, N. C.

The M. A. Hofft Co., Indianapolis, Ind., manufacturer of the National Stoker and the National Arch, have appointed Mr. William R. Van Nortwick, Room 1567, 50 Church St., New York, representative in the New York territory.

The Crocker-Wheeler Co., Ampere, N. J., announces that it has closed its Baltimore office; that it has opened an office in Atlanta, Ga., at 101 Marietta Bldg., which is in charge of George D. Anderson, Jr.; S. M. Conant, formerly in charge of the Baltimore office has been appointed assistant sales manager and is located at Ampere; the Pittsburgh office, in charge of J. R. Lewis, will move from the Henry W. Oliver Bldg. to the Dravo Bldg., 300 Pennsylvania Ave., Pittsburgh, Pa.

The Riley Stoker Corp., Worcester, Mass., announces changes in organization: William Pestell, for a long time connected with the company and well known in the power-plant field, has been made vice-president of the company; G. H. Sanger, formerly at the Philadelphia office, has been transferred to the Chicago office, 541 Marquette Bldg.; the new representative for the Denver and Salt Lake district is the Mine & Smelter Supply Co., 17th and Blake Sts., Denver, Colo.

Trade Catalogs

Valves, Blow-Off — Yarnall-Waring Co., Chestnut Hill, Philadelphia, Pa., Folder, "8,000 Plants Are Using This Means of Saving Steam," describes these tandem blowoff valves for any pressure, and gives a partial list of users.

Stokers, Hand — Marion Machine Foundry & Supply Co., Marion, Ind. Catalog No. 60-R describes the hand stokers Type C, Type A, hopper feed, and Marion Auxiliary Air Inlet. Illustrations, drawings and tables of dimensions and capacities are included.

Fans & Blowers—American Blower Co., Detroit, Mich. Bulletin No. 1801 describes the construction of "Sirocco" fan, together with complete capacity and dimension tables for the engineer's use. Leaflet No. 1423, "ABC Air Washing and Cooling Fan," and leaflet "American Direct Fired Unit Heater," is Bulletin No. 2117. These are also ready for distribution.

Coming Conventions

American Association of Oil Burner Manufacturers. Leod D. Becker, Bank of Galesburg Bldg., Galesburg, Ill. Convention and exhibit at Edgewater Beach Hotel, Chicago, April 1-3.

American Chemical Society. Dr. Chas. L. Parsons, Mills Bldg., Washington, D. C. Meeting at Baltimore, April 6-10.

American Electrochemical Society. Dr. Colin G. Fink, Columbia University, New York City. Convention at Niagara Falls, April 23-25.

American Institute of Electrical Engineers. F. L. Hutchinson, 29 West 39th St., New York City. Convention at St. Louis, April 13-17. Annual convention at Saratoga Springs, June 22-26.

American Society of Civil Engineers. George T. Seabury, 29 West 39th St., New York City. Spring meeting in Cincinnati, April 22-24.

American Society of Mechanical Engineers—Calvin W. Rice, 29 West 39th St., New York City. Spring meeting at Milwaukee, Wis., May 18-21.

American Water Works Association. W. N. Niesley, 170 Broadway, New York City. Convention at Louisville, Apr. 27-May 3.

Eastern Ice Association—William H. Ross, 35 Warren St., New York City. Fourth Spring meeting at Fort Pitt Hotel, Pittsburgh, Pa., on March 31-April 1.

Exposition of Inventions—American Institute, E. W. Bartlett, 47 West 34th St., New York City. Exposition at Engineering Societies Bldg., 29 West 39th St., New York City, April 27 to May 2.

Master Boiler Makers Association. H. D. Vought, 26 Cortlandt St., New York City. Convention at Chicago, May 19-22.

Mid-West Power Show at Milwaukee, Wis., May 18-21. Ralph H. Cahill, care of Mid-West Power Show, City Hall, Milwaukee, Wis.

National Association of Stationary Engineers. F. W. Raven, 417 South Dearborn St., Chicago, Ill. National convention and exhibition at St. Paul, Minn., Aug. 31-Sept. 4. Annual conventions and exhibitions of state associations are scheduled as follows: **Indiana State Association** at Purdue University, Lafayette, Ind., April 20-23. W. C. Knowles, Northern Indiana Gas & Electric Co., Lafayette, Ind. **Kansas Association** at Topeka, May 6-8. J. M. Van Sant 739 Horne St., Topeka. **Pennsylvania Association** at Pittsburgh, Pa., May 15-16. Frank J. McCarron, 3647 North 11th St., Philadelphia, Pa. **Wisconsin Association** at Milwaukee, May 18-22. F. W. Horn, 256 29th St., Milwaukee, Wis. **New Jersey Association** at Atlantic City, June 4-8. H. W. Vail, 1244 Park Ave., Plainfield, N. J. **New York Association** at New York City, June 11-13, W. T. Meinzer, 3rd St., near Warburton, Bayside, L. I. **Iowa State Association** at Ottumwa, June 16-18. F. L. Stocker, 127 S. Elm St., Ottumwa, Iowa. **New England States Association** at Worcester, Mass., July 10-12, formerly announced June 18-20. F. L. Tyler, 32 Briggs St., Taunton, Mass. **Ohio Association** at Middleton, Ohio, June 18-20. T. S. Garrett, 2622 East Second St., Dayton, Ohio. **Connecticut Association** at New Haven, June 25-27. George F. Klopfer, 30 East Pearl St., New Haven. **Michigan Association at Muskegon,** July 15-17. Charles Unterreiner, 5522 Underwood Ave., Detroit, Mich. **Minnesota Association** at St. Paul, Aug. 24-28. C. A. Nelson, 800 22nd Ave., Minneapolis, Minn.

National District Heating Association. D. L. Gaskell, Greenville, Ohio. Sixteenth annual convention at West Baden Springs Hotel, West Baden, Ind., May 19-22.

National Electric Light Association. M. H. Aylesworth, 29 West 39th St., New York City. Annual convention at San Francisco, June 15-20.

Relays—General Electric Co., Schenectady, N. Y. Bulletin No. 47640.2 gives complete descriptions, applications and the operation of these induction time over-current relays, types IA-201, IA-202, IA-205 and IA-206.

Transformers, Speed—The Poole Engineering & Machine Co., Baltimore, Md. Bulletin 106 describes type "K" speed transformer which is a herringbone spur gear drive. Bulletin No. 105 describes type "H" speed transformer. The bulletins are well illustrated with photos of these new types.

Pumps — The Gould Manufacturing Co., Seneca Falls, N. Y. "Investigation of the Performance of Centrifugal Pumps When Pumping Oils," by Robert L. Daugherty, is Bulletin 126 recently issued by the company. The result of these tests and charts showing the performance of centrifugal pumps handling petroleum products ranging from gasoline to oil of 7,000 Saybolt viscosity as compared to performance when handling water, are included.

Fuel Prices

COAL

The following table shows the trend of the spot steam market in various coals, f.o.b. mines; *mine run* except Pittsburgh gas slack (*Coal Age*):

Bituminous, Net Tons	Market Quoting	Mar. 9, 1925
Pool 1	New York	$2.50@$2.85
Smokeless	Boston	1.62
Clearfield	Boston	1.75@ 2.20
Somerset	Boston	1.90@ 2.35
Kanawha	Columbus	1.40@ 1.60
Hocking	Columbus	1.35@ 1.60
Pittsburgh	Pittsburgh	1.75@ 1.90
Pittsburgh gas slack	Pittsburgh	1.25@ 1.35
Franklin, Ill.	Chicago	2.25@ 2.50
Central, Ill.	Chicago	2.15@ 2.25
Ind. 4th Vein	Chicago	2.25@ 2.50
West Ky.	Louisville	1.25@ 1.50
S. E. Ky.	Louisville	1.25@ 1.50
Big Seam	Birmingham	1.50@ 2.00
Anthracite, Gross Tons		
Buckwheat No. 1.	New York	$2.00@$3.15
Buckwheat No. 1.	Philadelphia	2.25@ 3.00
Birdseye	New York	1.35@ 1.60

FUEL OIL

New York—Mar. 19, light oil, tank-car lots; 28@34 deg. Baumé, 6½c. per gal.; 36@40 deg., 6¾c. per gal., f.o.b. Bayonne, N. J.

St. Louis — Mar. 10, tank-car lots, f.o.b. St. Louis; 24@26 deg., $1.95 per bbl.; 26@28 deg., $2.00 per bbl.; 28@30 deg., $2.05 per bbl.; 30@32 deg., $2.10 per bbl.; 32@36 deg., gas oil, 5½c. per gal.; 38@40 deg., 5.9c. per gal.

Pittsburgh—Mar. 16, f.o.b. local refinery; 30@34 deg. fuel oil, 6¾c. per gal.; 36@40 deg., fuel oil, 7c. per gal.

Dallas—Mar. 16, f.o.b. local refinery, 26@30 deg., $1.80 per bbl.

Philadelphia—Mar. 13, 28@30 deg., $2.73@$2.793 per bbl.; 18@22 deg., $2.42@$2.483; 13@16 deg., $2.10@$2.163 per bbl.

Boston—Mar. 16, tank-car lots, f.o.b.; heavy oil, 12@14 deg., Baumé, 4¾c. per gal.; light oil, 28@32 deg. Baumé, 6c. per gal.

Cincinnati — Mar. 17, tank-car lots, f.o.b. local refinery, 24@26 deg. Baumé, 6½c. per gal.; 26@30 deg., 6¾c. per gal.; 30@32 deg., 7c. per gal.

New Plant Construction

Ariz., Tombstone—City will soon receive bids for the construction of a municipal light, power and ice plant. Estimated cost $25,000. Equipment will be required. J. L. Vermeersch, 18 East Jefferson St., Phoenix, is engineer.

Ark., Fayetteville—City, plans an election to vote $200,000 bonds for the construction of an electric light plant.

Calif., Los Angeles — Frank Wiggins Memorial Hospital Association, c/o Walker & Eisen, Great Republic Life Bldg., Archts., is having plans prepared for the construction of a hospital at 1st and Alvarado Sts., 1,000 bed capacity.

Calif., Los Angeles — Subway Terminal Corporation, c/o Schultze & Weaver, Pacific Mutual Bldg., Archts., awarded contract for the construction of a 12 story railway terminal and office building to P. J. Walker Co., Garland Bldg., on fixed fee basis, approximately $2,500,000.

Conn., Norwalk—Crystal Ice Co. is in the market for ice and refrigeration equipment for plant addition.

D. C., Washington—Navy Department, Bureau of Yards and Docks, will soon receive bids for four 300 hp. watertube boilers, with mechanical stokers; 1 turbine driven and 1 motor driven force draft fan for Navel Hospital. (Spec. 5082)

Ill., Witt—Indiana & Illinois Coal Co., T. C. Keller, Pres., will build a steam power plant, with day labor. Estimated cost $100,000. Power and light will be supplied to mines in Witt, Nokomis, Hillsboro, Taylor Springs, etc.

Ind., Lapel—Town plans the construction of a waterworks system including pumping equipment.

Kan., Enterprise—Kansas Flour Mills Co., Postal Telegraph Bldg., Kansas City, will receive bids after March 25th, for grain elevator and equipment, including three 24 in. belt conveyors, electrically driven elevator, requiring three 30 hp., one 15 hp., two 10 hp. four 7½ hp., two 5 hp. electric motors, etc. Estimated cost $100,000. Horner & Wyatt, 300 Board of Trade Bldg., Kansas City, are engineers and architects.

La., New Orleans—Milan Morgan Co., Paris Ave., plans the construction of a 70 ton daily capacity ice plant at Gentilly Rd. and Peters Ave. Refrigerating machinery will be required. Estimated cost $100,000.

La., New Orleans — New Orleans Ice Cream Co., Barron and Thalia Sts., is in the market for a 25 to 50 hp., coal burning, locomotive type, boiler to carry 100 lbs. of steam, one preferably 40 hp. (new or used).

La., New Orleans—Vivien Ice Manufacturing Co., 87 French Market, L. T. Vivien, Pres., plans the construction of a 15 ton daily capacity ice plant, at Gentilly Rd. and the Southern Pacific R.R. tracks.

Mass., Lawrence—City plans the construction of a 5,000,000 g.p.d. filtration plant, turbine driven centrifugal pump and auxiliaries, 140 hp. Morris Knowles, Inc., Westinghouse Bldg., Pittsburgh, Pa., is engineer.

Mass., Montague—Bd. of Selectmen plans the construction of a municipal lighting plant. Estimated cost $50,000. Architect and engineer not selected.

Mich., Detroit—Public Lighting Commission, 174 East Atwater St., F. Mistersky, Gen. Supt., is in the market for boiler feed pump units; condensed tubes and ferrules, and 2 bridge cranes, for new power plant.

Mich., Detroit — Whitney Estate, 1835 David Whitney Bldg., is having plans prepared for the construction of a 25 story office building at Madison and Witherell Sts., including steam heating equipment. Architect's name withheld.

Minn., Fairmont—Water and Light Commission, H. J. Waite, Secy., will receive bids until March 31st, for the equipment for light, power and heating plant, including boilers, superheaters, and breeching, automatic stokers, etc. Estimated cost $30,000.

Mo., St. Louis—John Ramming Machine Co., 300 South Main St., is in the market for oil engines, 50 to 75 hp., Y type; belted air compressor.

Neb., McCook—City plans an election in April to vote $172,000 bonds for the construction of a light and power plant.

N. H., Manchester—Manchester Traction, Light and Power Co. awarded contract for enlarging boiler house at Kelley's Falls, including installation of 1,495 hp. boiler, with feed water heater and necessary auxiliaries to Stone and Webster, Inc., 147 Milk St., Boston, Mass.

N. C., Apex — Town, E. G. Sinclair, Mayor, Town Hall, will receive bids until April 15th, for the construction of waterworks and sewerage system, including motor driven centrifugal pumps and accessories. G. C. White Co., Durham, is engineer.

N. D., Beulah—Knife River Coal Co. will purchase equipment for power plant, including boilers, etc. Also plans 10 miles of 2,300-v. transmission lines, and steel tipple, 2,500 tons per 8-hr. shift capacity. Estimated cost $50,000.

N. D., Bismark—Hughes Electric Co., will purchase equipment for power plant, including 1250 kw. steam turbine, boilers, condensing apparatus, cooling pond, etc. Estimated cost $75,900. E. A. Hughes, is engineer.

N. D., Dickinson—Hughes Deiters Co. plans improvement to central heating system, including installation of boilers, also plans 25 miles of transmission line. Estimated cost $100,000.

O., Mariemont—Mariemont Co., 1 Baker Court, Cincinnati, plans the construction of a 4 story hospital, here. Estimated cost $500,000. Sam Hannaford & Sons, 1024 Dixie Terminal Bldg., are architects.

O., Zanesville — Columbus, Newark and Zanesville Electric Railway Co., C. E. Moran, Gen. Supt. of electrical operating, plans the construction of a power station on Linden Ave. Estimated cost $50,000.

Okla., Newkirk—City, W. E. Alton, Clk., plans election, April 7th, to vote $115,000 bonds, for waterworks improvements including 2 wells, triplex pumps, motors, reservoir, etc. F. B. King, Grain Exchange, Oklahoma City, is engineer.

Okla., Tulsa — J. M. Gillette, Seaman Bldg., has had plans prepared for the construction of an 8 story building, at 4th and Boulder Sts. Estimated cost $500,000. E. W. Saunders Comm. Bldg., is architect.

Pa., Philadelphia—Equitable Realty & Holding Coporation, c/o A. F. Gilbert, 358 Fifth Ave., New York City, Archt. and Engr. awarded contract for the construction of a 22-story theater, store and office building, with steam heating system at Broad and Locust Sts., here, to Lynch Construction Co., Inc., 1 Pershing Sq., New York City. Estimated cost $6,000,000.

S. C., Greenville—Carolina Public Service Co., c/o Stone & Webster, Inc., 120 Broadway, New York City, awarded contract for the construction of an ice plant, 100 tons daily output, to Gollivan Construction Co., Greenville.

Tenn., Dickson—People's Ice and Cold Storage Co., plans the construction of an ice and cold storage plant. Estimated cost $40,000.

Tenn., Memphis—U. S. Veterans Bureau, Construction Division, 791 Arlington Bldg., Washington, D. C., awarded contract for the construction of a hospital addition including laundry and ice plant, to Veterans Hospital, on Lamar Blvd., here, to D. D. Thomas & Son, $32,975. Major C. D. Allen, medical director in charge, here.

Tenn., Nashville—Cotton States Life Building, awarded contract for the construction of a 10-story office building, at 6th and Deaderick Sts., to Son Fins Concrete Construction Co., 50 East Ellis St., Atlanta, Ga. Estimated cost $500,000. Charles Loridans is president.

Tenn., St. Elmo—Fowler Lewis Oil Refining Co., 5415 Beulah Ave., J. V. Lewis, Pres., plans the construction of a plant for the reclamation of waste lubricating oils including tank and switch yards, on 2 acre site, here. Equipment including steam pumps, 100 hp. boiler, etc., will be required. F. E. Fowler is engineer.

Tex., Amarillo—City, E. Blasdel, Mayor, voted $1,750,000 bonds for waterworks improvements, including two 3,000 g.p.m. horizontal pumps, etc. H. B. Jones is engineer.

Tex., Dallas—Thomas & Swaine, Southwestern Bldg., Archts., are preparing plans for the construction of a 9-story apartment house, on Turtle Creek Blvd. Estimated cost $750,000. Owner's name withheld.

Tex., Dilley—City, R. Busby, Mayor, will soon receive bids for waterworks improvements, including pumping machinery, distribution system, etc., also construction of 15 ton capacity ice plant. Owner will purchase electric generating machinery and equipment for ice plant. Estimated cost $30,000. Terrell Bartlett Engineers, 612 Calcasieu Bldg., San Antonio, are engineers.

Tex., Gonzales—Stahl Bros. are having plans prepared for the construction of addition to a cold storage plant. Estimated cost $20,000. Equipment will be required. W. Noonan, Moore Bldg., San Antonio, is architect.

Tex., Idalou—City will receive bids after March 30th for the construction of a waterworks system, including pumping equipment. Estimated cost $30,000. Montgomery & Ward, 1016 City National Bank Bldg., are engineers.

Tex., Mineral Wells—Sidney Webb & Co., S. Webb, Pres., plans the construction of a hotel to replace fire loss. Estimated cost $750,000. Architect and engineer not selected.

Tex., Vernon—Texas Central Power Co., Frost National Bank Bldg., San Antonio, awarded contract for the construction of an ice plant, 20 tons per day capacity, here, to Sumner Sollitt Co., National Bank of Commerce Bldg., San Antonio. $18,300.

Wash., Centralia — Western Cross Arm and Manufacturing Co. plans the construction of a power plant here. Estimated cost $100,000. Company has contracted to furnish city light and power for 10 year period.

Wis., Kaukauna—Green Bay & Mississippi Canal Co., Insurance Bldg., Appleton, Wis., W. Van Nortwick, Mgr., is having plans prepared for the construction of a hydro-electric development, including power house and dam, at Rapid de Croche. 4 miles north of here. Estimated cost $500,000. Private plans.

Wis., Milwaukee — American Wholesale Grocery Co., 235 Broadway, awarded contract for the construction of a warehouse and cold storage plant, to H. Schmitt & Sons, 430 Farwell Ave. Estimated cost $60,000. Refrigerating machinery will be required.

Wis., Milwaukee—M. Rice, 414 Milwaukee St., et al, is having preliminary plans prepared for the construction of an 11-story hall, office and store building. Estimated cost $1,750,000. Judell & Bogner, 445 Milwaukee St., are architects.

Wis., Wisconsin Rapids — City, C. P. Gross, Mgr., will receive bids until April 14th for the construction of a filtration plant, including two low lift centrifugal pumps with motors and starters; one, 700 g.p.m. pump without motor or base; heating system, including boiler, radiators, etc. W. G. Kirchoffer, 22 North Carroll St., Madison, is engineer.

B. C., Vancouver—McCarter & Nairne, 509 Richards St., Archts., will receive bids about May 1, for the construction of an 8 or 10-story hotel on Seymour St., here, for an American syndicate. Estimated cost $1,000,000.

Ont., Bradford—Township of West Gwillimbury, F. Richie, Gilford, Clk., will receive bids until April 6 for construction of a drainage system, to reclaim part of Holland Swamp here. Estimated cost $150,000. Equipment including pumps, etc., will be required. A. Baird, Royal Bank Bldg., Sarnia, is engineer.

Ont., Frankford—Kerry & Chace Ltd., Confederation Bldg., Toronto, engrs., are receiving bids for two 1300 hp. turbines, vertical type with electric generators, exciters, governors, etc., for the Canadian Paperboard Co., here. Estimated cost $100,000.

Ont., Welland — Town is having preliminary plans prepared for the construction of a waterworks filtration plant, including electric pumps. Estimated cost $300,000. W. Chipmen, Mail Bldg., Toronto, is engineer.

Que., Chicontinni—Cie Electrique de Chicontinni is having plans prepared for the construction of a dam and hydro-electric power house, including 2 turbines. Estimated cost $500,000. H. Cimon, Quebec, is engineer.

Que., Nominingue — D. J. Valiguette, plans the construction of a water power and electric system. Estimated cost $25,000.